WHITE'S

NEW COURSE IN ART INSTRUCTION

MANUAL

FOR

EIGHTH YEAR

BOSTON · NEW YORK · CHICAGO

THE PRANG EDUCATIONAL COMPANY

MANUAL

FOR

EIGHTH YEAR GRADE

INCLUDING

AN OUTLINE OF THE YEAR'S WORK

WITH SUGGESTIONS FOR TEACHING

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BOSTON   NEW YORK   CHICAGO

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WHITE'S

NEW COURSE IN ART INSTRUCTION.

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INTRODUCTORY.

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WHITE'S NEW COURSE IN ART INSTRUCTION embodies the ideas and experience of many persons who, starting at widely separated points and working along different lines, have arrived almost simultaneously at the same conclusions.

It differs from other courses in plan, method, aims, and in its order of lessons.

I. **Its plan** comprehends the entire subject of art instruction, from which the several departments of the work and their subdivisions are derived. It follows, therefore, that the divisions are logical, natural, and recognized by established usage. Thus, the department of Geometric Drawing naturally and logically includes measurement, geometry, working drawing, development, and, in short, the whole realm of mathematical, or instrumental, drawing. The department of Decorative Drawing embraces the study of color, historic ornament, botanical drawing, and the employment of the information thus gained in making original decorative designs, in paper-cutting, etc. Pictorial Drawing is the comprehensive term employed to cover all the elements of freehand drawing of the appearance of regular solids and simple objects, sketching from nature, etc.

II. **The methods** employed are determined by the laws of the mind. Since the object itself impresses the mind more vividly and accurately than any representation of the object, models and objects take the place

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of pictures to be copied throughout the course; that is, pupils draw from real things, not from pictures. Since the mind acts according to certain laws, great care has been taken to correlate the various divisions of the subject in order that the mind may pass naturally from one to another. Since different minds have individual peculiarities, great freedom is allowed the individual pupil in the application and expression of his own ideas; and this is done, while adhering closely to underlying principles. Since the most rapid and substantial development of the mind occurs under intelligent guidance, an abundance of illustrative material is provided from which the pupils are led to discover principles, laws, relations, styles of handling, etc. These illustrations convey a great amount of information, but are in no sense *copies*.

III. **Its aims** are, first, to acquaint pupils with the rudiments of all kinds of drawing included under the two departments, mechanical and freehand, for the two are equally important, — one underlying all the industrial arts, and the other all the fine arts; therefore, provision is made for the related development of these two departments from the lowest grade throughout the course.

Second, to lead pupils to feel that, while art and love for the beautiful may be fostered by an artistic and beautiful environment, skill and power and quick original perception of beauty come only through faithful and persistent practice in drawing; for this reason correct proportions, accurate measurements, and exact truthfulness in drawing are considered of chief importance.

And, third, to develop a love for the beautiful in nature and in art. By the comprehensive study of color and form, it leads to mineralogy and other natural sciences; through historic ornament to mythology, ancient history, and historic art of all kinds; through plant form, to botany and original design; through model and object drawing, to pictorial art; and through the different divisions of geometric drawing, to manual training and all the manifold constructive arts.

IV. **The order of lessons** follows from the plan and aim of the course. While the teacher may modify any given lesson, suiting it to the needs of individuals or to particular classes, the general order should not be disturbed unless by omissions or additions which still recognize sound pedagogical principles.

GRAMMAR COURSE.

The teacher of each grade should be familiar with the work of other grades, that the lessons may be progressive from grade to grade. The entire grammar course is, therefore, here outlined to show the relation of the various divisions.

Pupils should enter the grammar grades with such a knowledge of color, form, and arrangement, that their chief attention may be given to representation, or drawing.

Drawing may be Geometric, Decorative, or Pictorial in character, according to the class of facts represented. That drawing in which the actual form and structure of artificial objects are represented is *Geometric*. That in which the enrichment, or decoration, of artificial objects is represented, and that which represents units, or motives, of design, whether natural or artificial, is *Decorative*. That in which the forms of objects are represented as they appear from one point of view is *Pictorial*.

A thorough understanding of geometric drawing demands a knowledge of measurement, geometry, projection, and development. A just appreciation of decorative drawing requires some knowledge of color, historic ornament, plant form, and design; and, if the pupil is to apply his knowledge of color in design, facility in paper cutting is necessary. Accurate knowledge of pictorial art and appreciation of its artistic qualities are gained by a study of the principles underlying the representation of geometric solids, and the application of these principles in the representation of natural and manufactured objects.

The grammar course, therefore, includes a study of Measurement, Geometry, Working Drawing, Development, Color, Historic Ornament, Botanical Drawing, Design, Paper Cutting, and Model and Object Drawing. A tabulated outline of this course is to be found on pages 12 and 13.

OUTLINE OF A LOGICAL COURSE IN ART.

GRADE OR YEAR IN SCHOOL	GEOMETRIC DRAWING.			
	MEASUREMENT.	GEOMETRY.	WORKING DRAWING.	DEVELOPMENT.
IV.	Use of Ruler. ⅛″	Classification of Rectilinear Figs.	Representation of Curved Surfaces.	Equal Plane Faces at right angles.
V.	Use of Ruler. ¹⁄₁₆″	Classification of Curvilinear and Mixtilinear Figs. (Instrumental.)	Representation of Curved and Plane Faces.	Unequal Plane Faces at right angles.
VI.	Drawing to Scale. Half size. Quarter size.	Simple Geometric Problems.	Representation of Invisible Parts. Plane Faces oblique in one view.	Plane and Curved Faces combined.
VII.	Drawing to Scale. 1½″ = 1′	Construction of Polygons.	Plane Faces oblique in one and two views. Three views.	Plane Faces at oblique angles.
VIII.	Drawing to Scale. ¾″ = 1′	Inscribing and Circumscribing.	Plane Faces oblique in two or more views. Sections — parallel.	Radiating Flats.
IX.	Drawing to Scale. ½″ = 1′ ¼″ = 1′	Advanced Problems. Tangents.	Sections — oblique. Intersections.	Truncated Radiating Flats.

INSTRUCTION FOR GRAMMAR SCHOOLS.

DECORATIVE DRAWING.					PICTORIAL DRAWING.
COLOR.	HISTORIC ORNAMENT.	BOTANICAL DRAWING.	DESIGN.	PAPER CUTTING.	MODEL AND OBJECT DRAWING.
Classification by Values. Scales of Color. Dominant Harmony.	Modified Geometric Units.	Drawings of Seeds, Buds, Fruits.	Modification of Regular Geometric Units. Contrast. Unity. Strength.	Mixtilinear Forms.	*Effect of Distance and Level.* Representation of Solidity.
Classification by Values (cont.) Scales of Color. Dominant Harmony.	Modified Bilateral Units.	Leaves — entire-margined.	Modification of Bilateral Units. Variety. Rhythm. Repose.	Bilateral Forms.	*Foreshortening.* Effect of Level.
Classification by Composition. Simple and Binary Colors. Complementary Harmony.	Conventional Plant Forms on radial main lines.	Leaves — serrate, notched, and lobed. Flowers.	Growth. Strict Conventionalization of Plant Forms.	Radial Forms.	*Foreshortening Reviewed.* Concentric Circles. *Convergence.* a. One set of retreating edges bounding a vertical plane. b. One set of retreating edges bounding a horizontal plane.
Classification by Composition (cont.) Simple and Binary Colors. Analogous Harmony.	Conventional Plant Forms on bilateral main lines.	Compound Leaves.	Growth. Free Conventionalization of Plant Forms.	Radial Forms (cont.) Surface Patterns.	*Convergence (cont.)* Two sets of retreating edges. a. At equal angles. b. At unequal angles.
Classification by Qualities. Natural and Acquired. Analogous Harmony (cont.)	Conventional Ornament on bilateral main lines.	Sprays.	Growth. Conventionalization of Sprays.	Original Forms.	*Use of Diagonals.* a. To test work. b. To find centers.
Classification by Qualities (cont.) Effects of Juxtaposition. Perfected Harmony.	Conventional Ornament on balanced main lines.	Whole Plants.	Growth. Conventionalization of Plants.	Original Forms.	*Relation of Axes.* a. To entire mass of solid. — Ovoidal. b. To one face of solid. — Conical. c. To two faces of solid. — Cylindrical. d. To all edges of solid. — Pyramidal.

The foregoing outline presents the entire grammar course in its simplest form.

Each vertical column shows the analysis of one of the ten divisions of representation. The Roman numerals at the left indicate the years of school life, and each horizontal line marks the programme in drawing for that year. The Drawing Books are arranged in accordance with this plan.

The teacher should familiarize himself with this outline, and refer to it frequently, so that he may be able to teach better that part of it prescribed for the particular grade he is teaching.

A careful study of the foregoing tabulated outline will reveal the connection between subjects in each grade and their relations to those of other grades. For example : In the eighth year, the accuracy required in measurement, including drawing to scale, prepares the pupil to work out problems in working drawing and development. The instrumental work in connection with geometry leads to the construction of inclosing forms in design. The flats of solids used in working drawing to furnish facts are constructed under development. Balanced main lines, naturally following the study in the seventh year of bilateral main lines, are taken up under design, and units illustrating these are given under historic ornament.

Thus each subject supplements others in the grade. The study of each subject is logically pursued throughout the grades ; for example, the analysis of the rectilinear figures studied in the fourth year, and of the curvilinear figures in the fifth, leads to the discovery of simple geometric problems in the sixth, by the use of which polygons are constructed in the seventh year. These polygons, combined concentrically in the eighth year, furnish problems in inscribing and circumscribing ; combined eccentrically in the ninth, they furnish problems in tangents.

All the divisions are similarly outlined, and the lessons under each are arranged to lead the pupil step by step to the complete knowledge of the subject.

MATERIALS.

Models. — Each class teacher should be supplied with Set No. 2 of White's Drawing Models. In addition, each grammar school should have one set of Drawing Models No. 3, and a sufficient number of each of the 2″ curvilinear solids to supply all the pupils of one class. The rectilinear solids for the pupils' individual use can be constructed from paper. The set of No. 3 solids and the curvilinear solids for individual use can be used by all the classes in turn.

Objects. — As called for in the course. As far as possible each pupil should furnish his own.

Drawing Books. — White's Drawing Books, to which the work of this course has been adapted, are to be used. There is a separate book for each year's work, to be filled by the pupils according to the directions given in the Outline.

White's Fourth Year Drawing Book is used in the fourth year.
White's Fifth Year Drawing Book is used in the fifth year.
White's Sixth Year Drawing Book is used in the sixth year.
White's Seventh Year Drawing Book is used in the seventh year.
White's Eighth Year Drawing Book is used in the eighth year.
White's Ninth Year Drawing Book is used in the ninth year.

Drawing Paper. — This should be of good quality, in sheets 9″ by 12″. That manufactured especially by, and to be obtained from, the publishers of the course is the best.

Development Paper. — Oak tag of medium weight, and in sheets 9″ by 12″, is required for the work in development.

Colored Papers. — White's Educational Colored Papers are required to complete the work in color, as outlined in this course. These are furnished in packages as follows : —

Package No. 4 for the fourth year.
Package No. 5 for the fifth year.
Package No. 6 for the sixth year.
Package No. 7 for the seventh, eighth, and ninth years.

Tracing Paper. — Tissue paper of good quality will do, although the tracing paper used by designers is preferable. One sheet, 9″ by 12″, will be required by each pupil every year.

Pencils. — These should be of good quality and of medium softness.

Erasers. — Flexible, elastic erasers are the best, such as will not rub off the surface of the paper. The using of a hard rubber frequently makes holes in the paper.

Rulers or Scales. — For the fourth and fifth years, industrial drawing scales are recommended. For the sixth, seventh, eighth, and ninth years, architects' triangular scales will be found most satisfactory.

Compasses. — Each pupil should be furnished with one of White's Patent Drawing Compasses, with pencil.

Scissors. — If possible, each pupil should have a pair of sharp, four or five inch, steel scissors of fair quality.

Glue. — Each pupil should have a bottle of liquid glue, for constructing designs with colored paper, and objects from developments.

Each pupil should be held responsible for the condition of his own materials.

OUTLINE OF EIGHTH YEAR'S WORK.[1]

(F<small>IFTH</small> G<small>RAMMAR</small> Y<small>EAR</small>. — D<small>RAWING</small> B<small>OOK</small> VIII.[2])

1. GEOMETRIC DRAWING.

I. MEASUREMENT.

Preliminary Work.

   a. Drill in use of ruler, and review scales previously used.
   b. Teach drawing to scale: $\frac{3}{4}'' = 1$.

II. GEOMETRY. (Drawing to be instrumental. For illustrations, see page 7.)

Preliminary Work.

   a. Review the geometric problems already taught, giving special attention to accuracy. Insist upon fine, definite lines.

Page 3. Inscribing and Circumscribing.

  1. Within a given circle inscribe a regular hexagon.
  2. Within a given circle inscribe a square.
  3. Within a given circle inscribe a regular pentagon.
  4. Within a given equilateral triangle inscribe a circle.
  5. Within a given square inscribe an octagon.
  6. About a given circle circumscribe an equilateral triangle.

Page 4. Foils.

  1. Copy the modified trefoil, Ill. 118, page 28, enlarged to properly fill the space.
  2. Copy the Gothic cinquefoil, Ill. 94, enlarged to properly fill the space.

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[1] A compact outline of the year's work is first presented, in which only essential directions and references to pages and figures in the Drawing Book are given, to make clear what is required. Detailed directions and suggestions are added under the heading of *Suggestions for Teaching* (see Contents).

[2] References to pages and figures in this Outline are to Drawing Book VIII.

Page 5. Original Inclosing Form.

1. Draw an ornamental inclosing form based upon one of the foils.

III. WORKING DRAWING. (Completed drawings to be instrumental. For illustrations, see pages 8 and 9.)

Preliminary Work.

a. Review previous work, including especially plane faces foreshortened in two views, and make freehand sketches of the square pyramid, where the faces are foreshortened in three views.
b. Teach *parallel sections and intersections.*
c. Make freehand sketches of a cone, a square pyramid, and an hexagonal pyramid cut by a horizontal plane.

Page 6. Parallel Sections.

1. Draw two views of a cone, a square pyramid, and an hexagonal pyramid. Represent a horizontal section of each.

Page 11. Application. A Common Object.

1. Draw two views and a section of some simple object. See Ills. 56, 57, and 58, page 8.

Page 12. Architectural Plan or Section.

1. Draw a plan of the schoolroom, to scale ; or copy Ill. 59, page 9.

IV. DEVELOPMENT. (Completed drawings to be instrumental. For illustrations, see page 10.)

Preliminary Work.

a. Review the work of the previous year.
b. Teach *radiating flats,* — first from an object, then from a drawing.
c. Make sketches of the flats of the type solids which illustrate the required conditions.

Page 13. Radiating Flat, Truncated.

1. Draw the flat of a square pyramid, an hexagonal pyramid, or a cone, or of a frustum of one of these. See Ills. 17, 18, and 19.
2. Construct, using development paper.

Page 14. Application.

1. Draw the flat of some simple object based on a frustum. See Ills. 20 and 21.
2. Construct, using development paper.

2. DECORATIVE DRAWING.

V. COLOR.

Preliminary Work.

    a. Review the previous work in color, especially that of the seventh year.
    b. Continue the study of *analogous harmonies.*
    c. Teach *classification by qualities — warm, cool.*
    d. Teach the *effects of juxtaposition*, using spectrum colors contrasted
        with black, white, and gray.

Page 23. Effects of Juxtaposition.

    1. Make arrangements, using spectrum colors and neutrals, — illustrating
        effects of juxtaposition.

VI. HISTORIC ORNAMENT. (Completed work to be either freehand or instrumental. For illustrations, see pages 15 and 16.)

Preliminary Work.

    a. Review bilateral main lines.
    b. Teach *balance.*

Page 17. Conventional Plant Forms on Balanced Main Lines.

    1. Enlarge Ill. 62, 63, or 64, page 16.
    2. Reproduce Ill. 57 or 58, page 15.

VII. BOTANICAL DRAWING. (Drawings to be freehand. For illustrations, see pages 21 and 22.)

Preliminary Work.

    a. Collect and study sprays of creeping, twining, and climbing plants,
        comparing them with the illustrations on pages 21 and 22.

Page 18. Natural Forms.

    1. Draw, from nature, a spray having leaves and buds, flowers, or fruits.

VIII. DESIGN. (Drawings to be either freehand or instrumental. For illustrations see pages 22, 27, and 28.)

Preliminary Work.

    a. Review principles previously taught, especially bisymmetrical main
        lines.
    b. Teach *balanced main lines.*

Page 19. Conventional Details.

    1. Conventionalize the natural forms drawn on page 18.

2. Draw an arrangement of balanced main lines similar to Ill. 111, 112, 113, or 115, on page 28.

Page 26. Design from Copy.

1. Copy Ill. 122, on page 27, enlarged to properly fill the space.

Page 25. Original Design.

1. In an ornamental inclosing form (see Ills. 118 and 119), make an original design on balanced main lines.

IX. PAPER CUTTING.

Page 24. Design in Color.

1. Construct either the original design, Ill. 119, or Ill. 122, using colored papers illustrating analogous harmony.

3. PICTORIAL DRAWING.

X. MODEL AND OBJECT DRAWING. (Drawings to be freehand. For illustrations, see pages 29 and 30.)

Preliminary Work.

a. Review previous principles, especially convergence at unequal angles and proportional measurement.

b. Teach the *use of diagonals :* first to test drawings ; second, to find centers.

Page 20. Use of Diagonals in Representing Foreshortened Ornament.

1. Draw the picture of a square prism having panels.

Page 31. Use of Diagonals in the Representation of Models.

1. Draw a cube and divide it as indicated in Ill. 57 or 58, page 29.
2. Draw a square pyramid in the position indicated in Ill. 63 or 64, page 29.

Page 32. Triangular Prism.

1. Draw a triangular prism as indicated in Ill. 59, page 29.

Page 33. Use of Diagonals in the Representation of Objects.

1. Draw a simple object based on the triangular prism or pyramid. (See Ills. 60, 61, 65, and 66, page 29.)

Page 34. Group.

1. Draw a group or make a sketch from nature, involving the use of diagonals. (See Ills. 67, 68, 69, and 70, page 30.)

SUGGESTIONS FOR TEACHING.

" Whatever knowledge is taught a child should be so taught that the act of acquiring it shall be of greater value than the knowledge itself."

— Dr. E. E. White.

1. GEOMETRIC DRAWING.

Geometric Drawing deals with the actual form and structure of objects. It includes *Measurement*, to determine and represent size and proportion; *Geometry*, to determine and represent underlying structure and relation; *Working Drawing*, to represent solid form; and *Development*, to obtain superficial area.

Geometric drawing should be accurate. Mechanical aids — the ruler and compasses — are indispensable. The best results, however, may be obtained only when geometric drawing is preceded by a careful study of solid forms, and freehand representation of their planes; hence, the first work in the eighth year grade should be a review of form.

GENERAL REVIEW OF THE STUDY OF FORM.

A. — Solids.

1. Curvilinear { Sphere. / Spheroids { Flat. / Long. } / Ovoid. }

2. Mixtilinear { Hemisphere. / Cylinder. / Half-cylinder. / Circular Plinth. / Cone. }

3. Rectilinear { Cube. / Prisms . . . . { Triangular. / Square. } / Square Plinth. / Square Pyramid. }

B. — Geometric Figures (*representing plane faces*).

1. Curvilinear { Circle / Ellipse / Oval } { Circumference. / Arc. / Center; Foci. / Diameter. / Axis. / Radius. }

2. Mixtilinear { Semicircle. / Quadrant. }

3. Rectilinear { Triangles . . . . . . { Base. / Altitude. / Vertex. } / Scalene (right-angled), / Isosceles, / Equilateral. / Quadrangles . . . . . { Diagonal. / Diameter. } / Square, / Oblong, / Rhombus, / Rhomboid. / Pentagon, etc. }

C. — Lines (*representing outlines or edges*).

1. Kinds $\begin{cases} \text{Curved} \cdot \\ \text{Straight.} \end{cases}$ $\cdot \begin{cases} \text{Circular.} \\ \text{Elliptical.} \\ \text{Oval.} \end{cases}$

2. Position $\begin{cases} \text{Horizontal.} \\ \text{Vertical.} \\ \text{Oblique.} \end{cases}$

3. Relation $\begin{cases} \text{Parallel.} \\ \text{At an angle} \end{cases} \begin{cases} \text{Right (perpendicular).} \\ \text{Oblique} \begin{cases} \text{Acute.} \\ \text{Obtuse.} \end{cases} \end{cases}$

D. — Points (*representing corners or marking positions*).

This last work leads directly to measurement, where the exact distances between corners and points are determined by using a ruler.

I. MEASUREMENT.

MATERIALS.

Ruler. — This should be of hard wood, with a straight sharp edge, one foot in length, and accurately divided into inches, halves, quarters, eighths, and sixteenths. Pencil marks should never be made upon the ruler, nor should its edge be cut or nicked.

Drawing Scales. — The best results will be secured if drawing scales similar to those used by draftsmen are furnished for each pupil. If prepared drawing scales are not furnished, teach each pupil to make his own scale, as follows : —

(*a*) Draw a fine sharp line 9″ long; divide it with the utmost accuracy into twelve equal parts of $\frac{3}{4}$ ″ each. (*b*) Mark the first point of division 0, the second 1′, the third 2′, and so on to the right end of the line, marking that 11′. (*c*) Divide the first part of this line

—the first *foot*—into fourths. (*d*) Beginning at 0, mark the first point of division toward the left 3″, the second 6″, the third 9″, and the left end of the line 12″. (*e*) Subdivide these spaces into *inches* and *half-inches.* (See Fig. 1.)
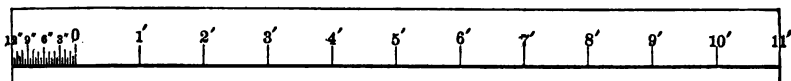
Fig. 1.

Practice taking dimensions from this scale. For example, to obtain a radius representing 3′ 6″, open the compasses to a greater distance than the one required, place the needle point on the 3′ division, and bring the pencil point to the 6″ division.

The other materials used are objects for measuring, and such tools as are used in geometry.

METHODS.

Measuring.—Measure accurately. Do not depend upon the figures on the ruler; become familiar with the divisions, so that measurements may be read either way, regardless of the figures. When determining short distances, do *not* measure from the extreme end of the ruler,—begin at some prominent division. The divisions at the extreme ends are often inaccurate.

Drill Exercises. —

(*a*) Practice drawing oblongs having the dimensions of the desk top, the window frame, the door frame, etc., using scales previously studied.

(*b*) Practice using the scale ¾″ = 1′.

After the first few exercises, all work in measurement should be in connection with geometry, working drawing, development, and other divisions of the course.

II. GEOMETRY.

Geometry begins with the study of the type solids, — sphere, cylinder, cube, — their divisions, and variations, in the primary grades. These solids were studied for their rectilinear faces in the fourth year, and for their curvilinear and mixtilinear faces in the fifth year. In the sixth year, the derived geometric fig-ures were used as the basis for simple geometric problems. In the seventh year, these geometric problems, and others similar, were used in the construction of geometric figures from given data. In this year, the comparative study of these figures is the basis for problems in inscribing and circumscribing. The problems of this and the preceding year are fundamental in all the constructive and decorative arts.

MATERIALS.

The materials should be of good quality. Good results are seldom obtained with poor tools.

The materials should be distributed in good condition before the lesson, should be handled carefully by the pupils, and returned in as good condition as when distributed. At first, reliable pupils chosen by the teacher may have charge of the materials; but as the members of the class gain self-reliance, each should be held responsible for his own tools, like any good workman.

Paper. — The paper should not be too rough. Smooth paper is best for first practice, for it does not so rapidly wear away the lead compass point. Thick, firm paper is prefera-ble, for it is not easily punctured and torn by the steel com-pass point.

Pencil. — For geometric drawing the best pencil is rather hard, — a No. 3, or an H. It should have a smooth conical point for general work; but for geometry, it should have a chisel point, made by sharpening a blunt conical point on two

opposite sides only. This pencil should be reserved exclusively for geometric drawing.

Ruler and Ruling. — The ruler should have a straight, sharp, thin edge. The points between which a line is to be ruled should not be covered by the ruler, but a little allowance should be made for the thickness of the pencil point. The ruler should be placed so that the light may shine upon the edge against which the line is to be ruled. The pencil should be held nearly upright, and the line drawn from left to right.

Compasses. — The compasses should have a sharp needle point, and a rigid lead point sharpened on two sides only, — that next the needle point when the legs are near together, called the inner side, and that opposite this, called the outer side of the lead. The compasses should be held between the thumb and first finger, at the end above the hinge (see Fig. 2); and, in describing arcs, they may be turned either to the left or right, as convenient. No hole should be visible at the center of a circle or arc ; if one appears, smooth the paper from the back with the thumb nail.
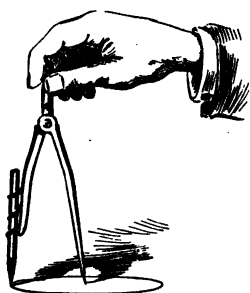
Fig. 2.

METHODS.

Preparation. — All the exercises of a lesson should be drawn by the teacher previous to its being given in class. They may be drawn upon charts or on the blackboard to assist in presenting or explaining the lesson. Such drawings are not to be copied by the pupils, but should be used for reference only. Know every step to be taken, and be prepared to illustrate each by rapid sketches upon the blackboard.

General Rules. — The following general directions, if strictly adhered to by the teacher, will do much to secure orderly lessons and the most satisfactory results : —

1. " Make haste slowly."

2. Exact attention, and then give each direction distinctly.

3. Make sure that each direction is understood, but avoid repetition.

4. Allow no one to work during an explanation. Give the pupils sufficient time to perform each process correctly. By proceeding slowly, excellent and uniform class work may be obtained and discouraging errors avoided.

5. Insist upon accuracy. Geometric construction has no value whatever if inaccurate.

6. Never tell a pupil what he may be led to discover for himself.

LESSONS.

(See Drawing Book VIII., page 7.)

Preliminary Work. — The review, upon practice paper, may be as follows : —

(*a*) Divide a 9″ × 12″ sheet into two equal parts, by ruling a line through the center, parallel to the short edges. Midway in the left space, draw a vertical line 4½″ in length. Upon this line as diagonal obtain the points for a regular hexagon. Join alternate points to form two equilateral triangles overlapping. ¼″ inside the lines of these triangles draw other lines parallel to them, forming equilateral triangles concentric with the first. Complete the figure to give the effect of interlacing. (See Fig. 3.)

Fig. 3.

(*b*) Midway in the right space, and 2¾″ above the lower edge, draw a horizontal line 2½″ in length. Upon this line as base construct a pentagon. With the center of each side as centers and a radius of ⅜″, describe semicircles inside the pentagon. ¼″ inside the lines of the pentagon draw other lines parallel to them, forming a second pentagon.
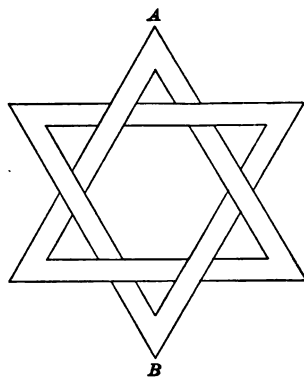
With the same centers as before and a radius $\frac{1}{4}''$ greater, describe arcs parallel to the semicircles, each end of which shall touch the lines of the inner pentagon. Complete the figure as indicated in Fig. 4.
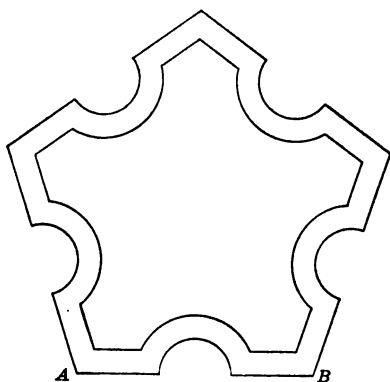
Fig. 4.

Page 3. Inscribing and Circumscribing. —

a. Draw margin lines $\frac{1}{2}''$ from the edges of the page.

b. Divide the space into six equal parts, nearly square.

1. *Within a given circle to inscribe a regular hexagon.* — (See Ill. 86.) Concentric with the upper left space draw a $2\frac{1}{4}''$ circle; draw a diameter, *AB.* From each end of the diameter set off on the circumference each way a distance equal to the radius of the circle, *CDEF.* Draw the hexagon, *ACDBFE.*

2. *Within a given circle to inscribe a square.* — (See Ill. 86 *b.*) Concentric with the upper middle space draw a $2\frac{1}{4}''$ circle; draw a vertical diameter, *AB*; bisect it, and draw a horizontal diameter, *CD.* Join the ends of these diameters to form the inscribed square, *ADBC.*

3. *Within a given circle to inscribe a regular pentagon.* — (See Ill. 87.) Concentric with the upper right space, draw a $2\frac{1}{4}''$ circle; draw a diameter, *AB,* and another, *CH,* perpendicular to it. Bisect *CD* at *E.* With *E* as center, and radius *EA,* draw the arc to *F.* With *A* as center, and radius *AF,* draw the arc to *G.* *AG* is one side of the regular pentagon.

4. *Within a given equilateral triangle to inscribe a circle.* — (See Ill. 89.) Midway in the lower left space and $\frac{5}{8}''$ above the lower boundary, draw the equilateral triangle *ABC* on a $2\frac{1}{2}''$ base. Bisect two of its angles. The bisectors intersect at *D,* the center of the required circle. *DE* is the radius of the circle.

5. *Within a given square to inscribe an octagon.* — (See Ill. 92.)
   Midway in the lower middle space draw a 2¼″ square,
   ABCD, whose base is ⅝″ above the lower boundary; draw
   its diagonals. With *A*, *B*, *C*, and *D* as centers, and a
   radius equal to one half a diagonal of the square, draw the
   arcs *EK*, *HL*, *GM*, and *FI*. Connect the points to form
   the octagon *EFGHIKLM*.

6. *About a given circle to circumscribe an equilateral triangle.* —
   (See Ill. 92 *b*.) Midway in the lower right space draw a
   1½″ circle, whose center is 1⅜″ above the lower boundary —
   draw a vertical diameter *AB*. With the same radius and
   A as center draw arcs intersecting the circumference at
   1 and 2. With a radius equal to *B* 2, and with 1, 2, and
   B as centers, draw arcs intersecting at *C*, *D*, and *E*. Draw
   CDE, the required triangle.

General Method for Inscribing Polygons in Circles. — Any regu-
lar polygon may be inscribed in a circle by the method illustrated
in Ill. 88. Draw any diameter *A* 1, and divide it into as many
equal parts as there are sides in the required polygon (in this
case, five). With *A* and 1 as centers and radius *A* 1, draw arcs
intersecting at 2. Draw a line from 2 through the second point
of division of *A* 1, to meet the circumference at *B*. *AB* is one
side of the required polygon. Using this as a measure, divide
the circumference, and *ABCDE* is the required polygon.

Page 4. **Foils.** — (See Ill. 94, and Ill. 118 on page 28 of Drawing
   Book.)

a. Draw margin lines.

1. *The Trefoil.* — With a radius of 2″ describe a circle whose center
   is 2⅝″ from the left margin and 3½″ from the lower margin;
   draw its vertical diameter and mark it *AD*. With the same
   radius and each end of the diameter as center, draw arcs
   intersecting the circumference at *B*, *C*, *E*, and *F*. Draw
   the equilateral triangle *ACE*. Draw *EB* and *FC*. Mark
   points 1, 2, 3, where the diameters intersect the sides of
   the triangle. With points 1, 2, and 3 as centers, and a
   radius equal to 1 *F*, describe semicircles outside the tri-

angle. $\frac{1}{4}''$ within the sides of the triangle draw lines parallel to them, forming a smaller concentric triangle.
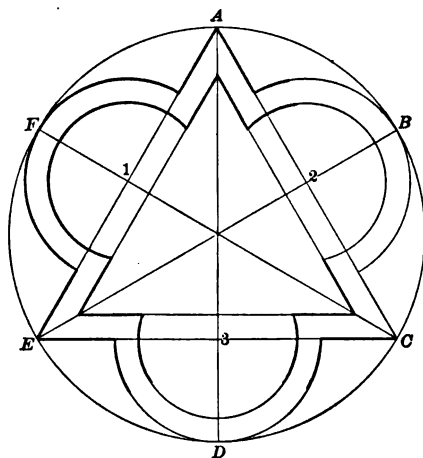
Fig. 5.

With centers 1, 2, and 3, and a radius $\frac{1}{4}''$ less than 1 F, describe arcs parallel to the semicircles, whose ends shall meet the sides of the inner triangle.   Complete the figure as shown in Fig. 5.

2. *The Gothic Cinquefoil.* — With a radius of 2″ describe a circle whose center is $2\frac{5}{8}''$ from the right margin, and $3\frac{1}{2}''$ from the lower margin.   Describe concentric circles with the following radii: $1\frac{13}{16}''$, $1\frac{11}{16}''$, $1\frac{5}{8}''$.   Beginning at the top, divide the circumference of the last circle into five equal parts at A, B, C, D, E.   From each of these points draw a diameter through the circle.   Mark the center of the circle 1; the end of the diameter to the left of A, 2; and the end of the diameter to the right of A, 3.   With a radius of $\frac{15}{16}''$ and a center at 1, draw short arcs intersecting 1 A, 1 B, 1 C, 1 D, and 1 E.   Connect these points of intersection to form a pentagon.   Mark its highest point 4, its point of intersection with 1–2, 5, and with 1–3, 6. With 4 as center, and radius 4–5, describe the arc 5–6. With the same center and radius 4 A, describe the arc

included between the lines 1–2 and 1–3. With a radius $\frac{1}{16}''$ greater, and the same center, describe similar arcs. Complete the figure as shown in Ill. 94, page 35.

Page 5. Original Inclosing Form. —

a. Draw margin lines.

1. Draw an original ornamental inclosing form based upon one of the foils, observing the following steps: *a,* determine the number of foils; *b,* draw the underlying geometric figure and any other lines which will be of assistance in the construction; *c,* draw the ornamental form.

RESULTS.

In geometric problems the *working lines* are those drawn in the various processes to obtain the result. They should always be light, but distinct and of uniform thickness, and should be retained in the finished problem. The *result lines* are those of the described problem. A *given line* is one of fixed dimensions from which the problem is worked. Both these should be very clearly defined lines, rather heavy, but not broad, and of uniform thickness and color.

In applications of geometric problems the construction lines should not appear in the finished work.

All successive steps in the process of solving a problem may be figured from 1 upward, and each result obtained lettered *A*, *B*, etc. If this practice is uniformly observed, the various steps in the construction can easily be followed.

A completed page of geometric drawing should have clean, dark margin lines, forming accurate corners; large, well-proportioned drawings placed symmetrically in the allotted spaces; and should show no finger marks or partially erased lines.

Whenever possible, the pupil should be required to invent processes of construction in making the figures, and to produce original results.

Geometry should lead the pupil to appreciate the underlying laws of construction.

ILLUSTRATIONS.
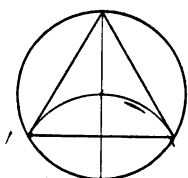
85. An equilat-
    eral triangle
    inscribed in
    a circle.

89. A circle in-
    scribed in
    an equilat-
    eral trian-
    gle.

86. A regular
    hexagon in-
    scribed in a
    circle.
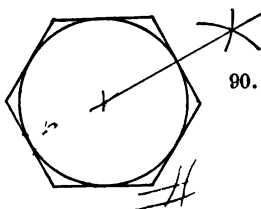
90. A circle in-
    scribed in
    a regular
    hexagon.

86 b. A square
    inscribed in
    a circle.
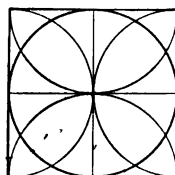
91. A circle cir-
    cumscribed
    with a
    square.

87. A regular
    pentagon in-
    scribed in a
    circle.
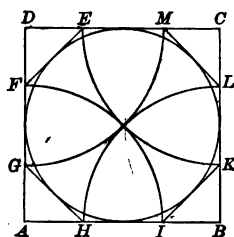
92. A regular
    octagon in-
    scribed in
    a square,
    and a cir-
    cle circum-
    scribed by
    an octagon.

88. A regular
    polygon
    inscribed
    in a cir-
    cle.
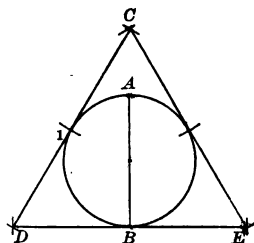
92 b. A circle
    circum-
    scribed
    by an
    equilat-
    eral tri-
    angle.
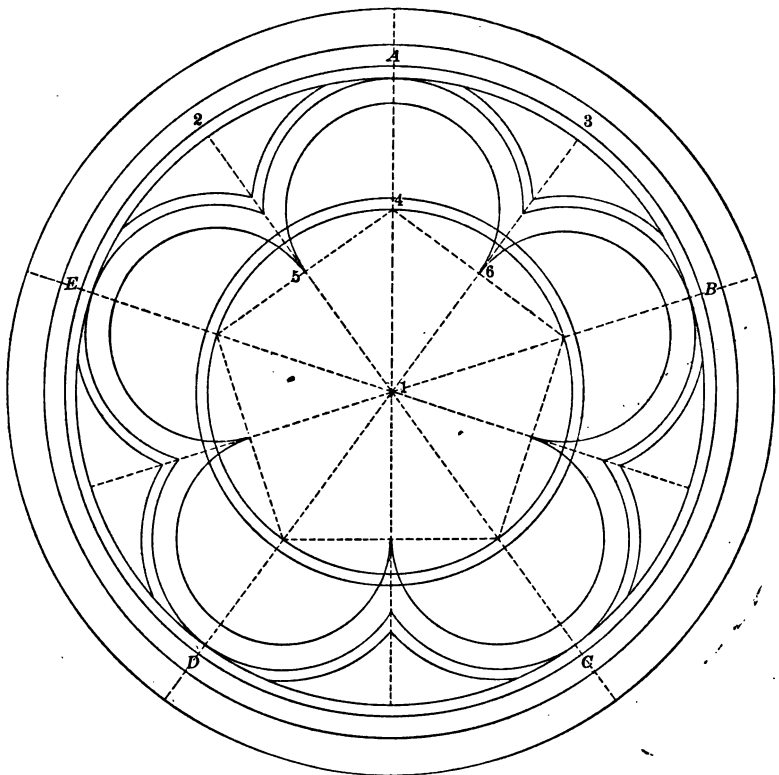
94. A Gothic cinquefoil.

III. WORKING DRAWING.

Working drawings are made to guide workmen in accurately constructing such objects as tools and other utensils, machines, houses, ships, etc.   They should give all needed information in regard to size, shape, and relation of the parts of the object to be made.

Views. — Solid objects have three dimensions, — length, width, and thickness.   The object cannot be seen its actual size in all three dimensions from any one point of view; and as working drawings must give actual facts of form, more than one drawing

of the object must be made. These drawings are made according to the principles of projection. These principles may be taught simply by using a book or slate held against the blackboard and revolved to represent the different planes; but three pieces of cardboard or thin wood, hinged as shown in Fig. 6, will more conveniently illustrate the principles. These three planes are named according to their positions: first, the *horizontal plane*, that upon
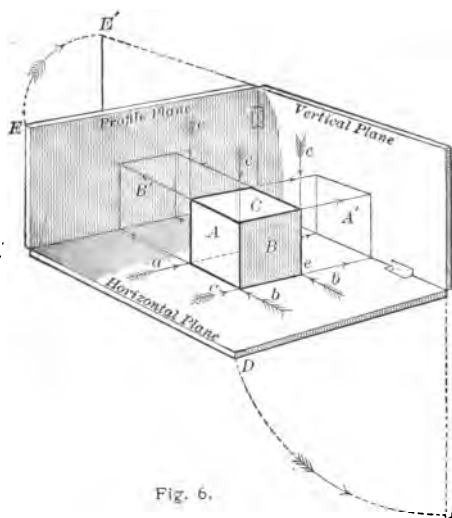
Fig. 6.

which the object rests; second, the *vertical plane*, behind the object; third, the *profile plane*, at either side of the object (in Fig. 6, at the left).

A person in front of the object, looking at it in the direction indicated by the arrows *aa*, would see only the face *A*. This would appear as a square seen against (projected upon) the vertical plane at *A'*. Looking at the object from the side, in the direction indicated by the arrows *bb*, the face *B* would appear as a square projected upon the profile plane at *B'*. Looking down upon the object in the direction indicated by the arrows *cc*, the face *C* would appear as a square

Fig. 7.

projected upon the horizontal plane. Now suppose the cube removed, the horizontal plane dropped down or revolved, as
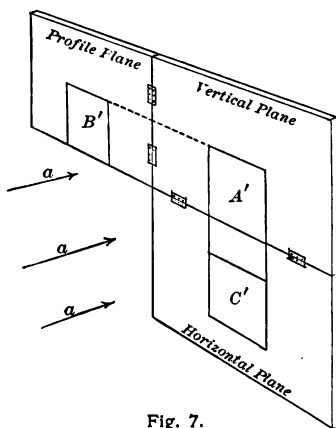
indicated by the arrow, to D', and the profile plane revolved as indicated to E'. The three planes are now vertical, and the three *views* of the cube appear upon them in their proper relations, as shown in Fig. 7. Or, to a person viewing them from the front, in the direction indicated by the arrows *aa*, the views would appear as in Fig. 8.[1] A' is the front view or *elevation;* B' is the side or end view (also called an elevation); C' is the top view or *plan.* Some objects require but a plan and elevation to show all their parts; others require three or more views.
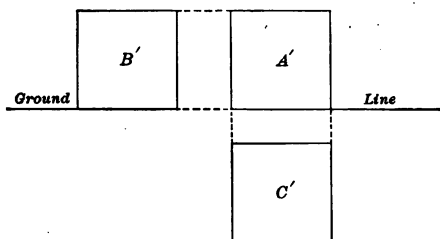
Fig. 8.

Objects Turned at an Angle. — An object is said to be turned at an angle when its principal edges are not parallel with the planes of projection. For example, if the cube in Fig. 6 were placed on the horizontal plane with the corner *e* nearer the vertical plane than any other corner of the base, the cube would be placed *at an angle.* If the cube were so placed that the edges of the base would make equal angles with the vertical plane, the cube would be placed *at 45°.* Were the corner *e* to be moved forward until the back edge of the base made an angle of 30° with the vertical plane, the cube would be placed *at 30° to the right.* The cube may be placed at any angle with the vertical plane, or with either of the other planes. A cube placed as shown in Fig. 43, page 13, Drawing Book VII., is *at 30° to the left.* When the angle may be made either to the left or right, the cube is said to stand at 30° and 60°.

In practical work, objects are seldom represented at an angle, except when drawn in perspective; but in such objects as architectural and machine details, certain parts must sometimes

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[1] In this figure, the lines dividing the planes are removed, with the exception of that between the horizontal and vertical planes, — which, for convenience, is retained, and called the *ground line,* — and the views are brought nearer together.

be so represented, and the underlying principles must be understood by the draftsman.

For convenience, plans are sometimes placed *above* elevations, and the side views are often transposed.
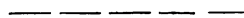
Position of Views. — The different views are grouped as convenient upon one sheet, or drawn upon different sheets. In either case, to avoid mistake, the different views are often lettered " front view," " top view," " side view," " end view," etc., as the case may be.

In simple drawings, like those required of the pupils, the front view is often drawn first, and the top view placed above it, or the bottom view below it ; or the view of the left side at the left, and of the right side at the right, of the first drawing.

In practice, the number and arrangement of views depend entirely upon the character of the object, and their arrangement upon the sheet is such that the relations of parts shown in the different views may be obvious.
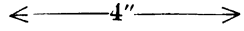
Conventional Lines. — Various kinds of lines are used with definite significance in working drawings : —

————————————— *Full, clear, dark lines* are used to represent visible parts.

— — — — — *Dashed lines* are used to represent invisible parts.

------------------- *Finely dotted lines* are used to connect different views.

— · — · — · — · *Dot-and-dash lines* indicate center lines or axes of objects. These are drawn only when necessary to locate accurately the centers of cylindrical, conical, or spheroidal objects.

⟵———4″———⟶ *Very fine continuous lines, with arrow points and figures,* indicate dimensions.
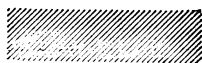
Very fine, continuous lines, parallel and at regular intervals, indicate that the object has been cut or sectioned. These lines, usually drawn at 45° with the principal lines of the object, produce *half-tinting.* In the section

of an object complete in one piece the lines of the half-tinting should have the same direction throughout, as in Fig. 9, *A*. In the section of an object showing more than one piece, a change in the direction of the lines of half-tinting indicates a different piece, as shown in Fig. 9, *B*. Sectional views presuppose objects cut upon a certain line, as *ab*.

Fig. 9.

MATERIALS.

Paper. — This should be of two kinds, — a cheap manilla paper for making preparatory sketches, and a paper of good quality with a granulated surface, like that in the Drawing Books.

Pencil, Ruler, and Compasses. — Same as for geometry.

Models. — Not only should a full set of type solids, large size, be at hand for purposes of illustration, but the objects from which working drawings are to be made should be in the school-room for observation, sketching, and measurement. While it would be well to have objects similar to those shown in the Drawing Book, it is neither necessary nor desirable that they should be identical.

METHODS.

Preparation. — Compare the drawings in Drawing Book VIII., pages 8 and 9, with the objects similar to those which they represent, and understand the meaning of each line.

Carefully plan and draw all sheets or pages of working drawing before attempting to teach the class. This is of utmost importance. The views should be grouped symmetrically in the allotted space, not crowded nor detached ; this means thoughtful planning before the lesson is given to the class. Make a freehand sketch from the object to be drawn, and mark the dimensions on the sketch. Make the finished drawing from the sketch.
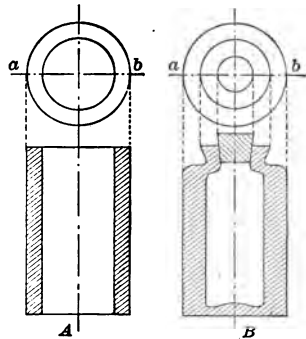
Preliminary Work. — In reviewing previous work use the type solids and Manual for seventh year. Compare the type solids with their representations, and know what each line represents. Give special attention to those models where plane faces appear foreshortened in two views, and make freehand sketches of the square pyramid whose faces appear foreshortened in three views.

Teach *parallel sections and intersections*, using the cone, square pyramid, hexagonal pyramid, etc., making freehand sketches upon the blackboard.

Sections. — In architectural and machine drawings three or more views are sometimes insufficient to give all the facts of form. The plans and elevations do not show facts of internal structure, which are often more important than external parts. In such cases the objects are represented as cut in two by planes passing through them in different directions. For example, in Ill. 57, page 8, *C* is a drawing of the oil cup of a steam engine as it would appear if cut in two, vertically, on the line *ab* in *A*. *D* is a plan of the lower part of the cup as it would appear if cut upon the line *cd*. Ill. 59, page 19, — the plan of a schoolhouse, — shows the top view of a section cut horizontally through the lower panes of the windows of the house drawn below it. *All floor plans of houses are representations of sections.* Ill. 61 shows a vertical section of Ill. 62. No new principles of projection are involved in the representations of plane sections.

The simplest way to teach sections is to use a model actually cut in two. A clay model will do, a wooden one is better ; but some simple object, like a pipe joint or tool handle, cut smoothly into two parts, showing the thickness of materials, internal forms, etc., is best for more advanced work.

Intersections. — When one part of an object joins or cuts into another part, the parts are said to intersect. For example, in

Ill. 57, page 8, the cap and neck intersect the bowl of the oil-cup; in Ills. 60 and 63, page 9, the chimney intersects the roof. The line where the parts meet is called the *line of inter-section.*

Page 6. Parallel Sections. —

a. Draw margin lines.

1. Draw two views of a cone, square pyramid and hexagonal pyramid, and represent a horizontal section of each cut by a plane parallel to the base and midway between base and apex. Locate the two views of the square pyramid first, in the center of the page; midway in the spaces at left and right, place the views of the cone and hexagonal pyramid. Obtain the section in the side view of the square pyramid first, and obtain that in the top view by projection. If this is understood by the class, the other sections may be obtained without help.

Page 11. Application. A Common Object. — (See Ills. 56, 57, and 58, page 8.)

a. Draw margin lines.

1. Draw two views and a section of a drain pipe, an oil cup, or a whistle, or some other common object. The order of procedure should be as follows: (*a*) select a simple object and make freehand sketches of two views; (*b*) make a freehand sketch of the sectional view; (*c*) make careful measurements of the object, and mark the dimensions on the sketches; (*d*) make the accurate drawing from the sketches, obtaining the section, so far as possible, from the other views.

Page 12. Architectural Plan or Section. — (See Ill. 59.)

a. Make a freehand sketch of the plan of the schoolroom, and mark its dimensions.

b. Draw margin lines.

1. Draw the plan of the schoolroom to scale, or copy Ill. 59.

Conventional Representation of a Wall, etc. — In architectural plans, *A*, in Fig. 10, is a conventional way of representing the

wall or partition of a framed building ; *B*, a window, and *C*, a door. The distance *ab* represents the distance between the outer surface of the building and the face of the plastering; *cc* represents the openings *in the clear* — that is, without doors or sashes hung. The double lines at *B* represent sashes. *d* represents a door, and indicates which way it opens.
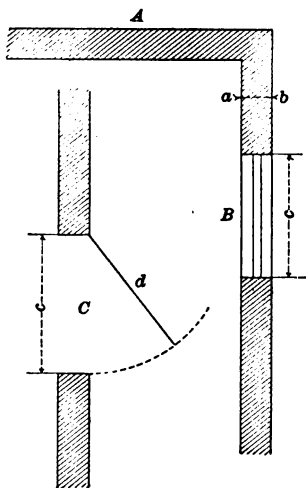
Fig. 10.

RESULTS. .

A clean, well-arranged page, accurately drawn and neatly lettered, is the ideal.

The lines representing the object should be of uniform strength throughout, and much heavier than all other lines used, so that they shall stand out in clear relief from them..

In more advanced, complicated drawings, the lines are sometimes varied in strength to indicate conventionally the relief of the parts.

Working drawing should lead the pupil to appreciate the value of accuracy.

ILLUSTRATIONS.

53. A cone and section.

54. A square pyramid and section.

55. An hexagonal pyramid and section.

53   54   55

56
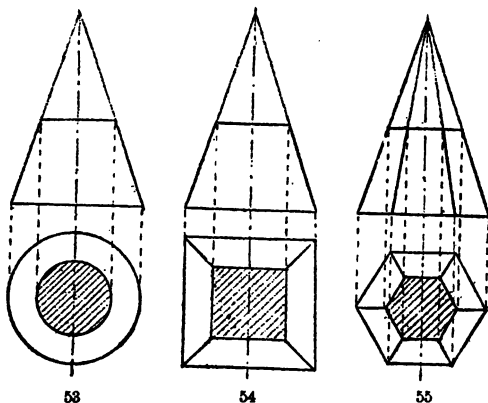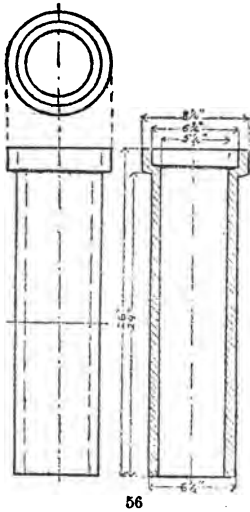
56. A drain pipe ; two views and a
longitudinal section, with di-
mensions.

57
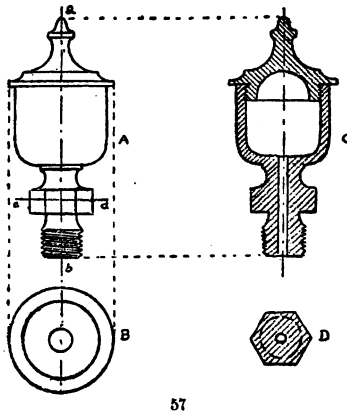
57. An oil cup of a steam engine.
A, side view ; *B*, plan ; *C*,
vertical section on line *ab* ;
D, horizontal section on line
cd.

5S
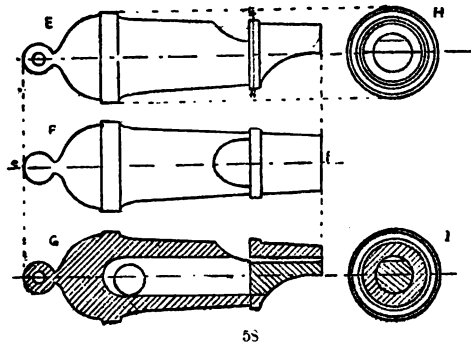
58. A whistle. *E*, side view ; *F*, top view ; *G*,
longitudinal section on line *ef* ; *H*, end
view ; *I*, transverse section on line *gh*.

59
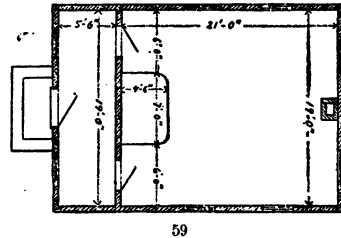
59. The plan of a country schoolhouse,
showing outside steps, entry,
teacher's platform, schoolroom,
chimney, doors, windows, etc.

60
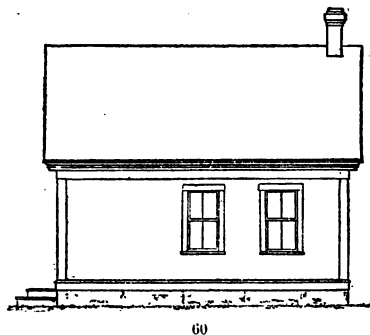
60. Side elevation of the same.
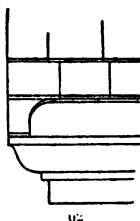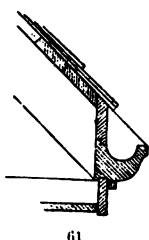
61. A section through the eaves and gutter of a
     cottage.
62. An elevation of the same.
63. End elevation of the country schoolhouse shown on page 43.

IV. DEVELOPMENT.

A development is a drawing which shows the entire surface of an object laid out in one plane, the different faces being of their actual shape and size.   A development in which the faces are properly arranged with laps added for joining the parts, cut from any thin material so that it may be bent or folded into the shape of the original object, is called a *flat*.

Developments are made for the construction of such objects as leather bags, shoes, boots, slippers, gloves, pocketbooks, cardcases, tin kitchen utensils, copper finials, ventilating ducts, and all other objects made of cloth, leather, paper, or sheet metal.

MATERIALS.

Paper.— Use practice paper for the first freehand sketches, but the final drawing should be made in the Drawing Book and transferred to oak tag, or paper of similar quality, if the object is to be constructed.

Pencil, Ruler, and Compasses. — Same as for geometry.

Scissors, or a sharp-pointed knife, will be required to cut the developments.

Glue. — A liquid glue, or paste equally adhesive, should be used.   Common, cheap mucilage is not satisfactory.

METHODS.

Preparation.— If the pupils have completed the work in Book VII., they will be able to understand the work of this grade without the assistance of developments made from paper by the teacher previous to the lesson. The only preparation required will be to plan the sheet or page before giving the lesson, to be sure that the drawing will be well spaced; and to know "by heart" each step to be taken by the class. If the class has not had previous drill, the first lessons should be those outlined in the Seventh Year Manual, pages 45–47.

LESSONS.

(See Drawing Book VIII., page 10.)

Preliminary Work. — In reviewing the work of the previous year, have the pupils sketch the flats of all solids having plane faces at oblique angles.

Teach radiating flats.

Radiating Flats. — When the principal lines in a flat radiate from a point, as in Figs. 17, 18, and 19, the flats are called *radiating* to distinguish them from others in which all the principal lines are parallel or at right angles to each other. The following is one method of illustrating the development of the surfaces of pyramidal and conical objects : —

Place a square pyramid on a sheet of paper, upon one of its triangular faces. Trace around the face. Turn the pyramid without allowing it to slip, so that it rests upon an adjacent triangular face. Trace around this face. So proceed until the four triangular faces have been traced. Stand the pyramid on its base with one edge coinciding with the lower line of one triangular face. Trace around the base. Add the laps ; cut out the flat ; fold into shape. When this process is understood, the development should be thought out from a freehand working drawing. Proceed as follows : —

a. Select the models which illustrate the condition, namely, square and hexagonal pyramids, cone, and frustums.

Make working drawings of them upon the blackboard; have pupils read these drawings, think the number of faces on each object, the shapes of faces and their relative positions.

b. Sketch the developments freehand upon the blackboard, obtaining the dimensions from the working drawings. Test these by comparing with paper flats made by the teacher.

c. Lead the pupil to foresee the necessity of laps and the value of so placing them that they will be of greatest advantage in constructing the object.
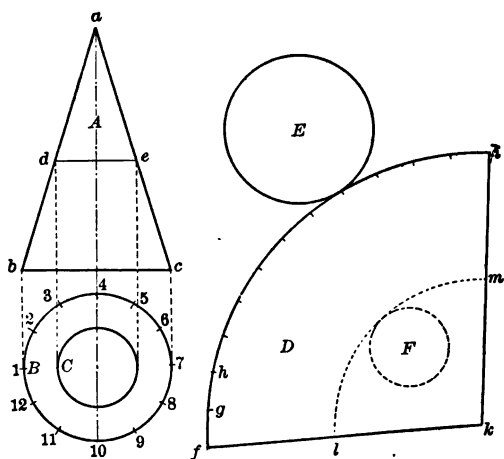
Fig. 11.

In developing the surface of conical objects, it will be seen in Fig. 11, that the slant height, ab, determines the radius, fk, of the arc fi, whose length is equal to the circumference of the base B, which is determined by subdivision as in the case of cylindrical objects; the distances 1, 2, 3, 4, etc., in B, corresponding to the same distances in D. The base E is of the same size and shape as B. In developing frustums, the process is the same up to this point ; then the slant height ad gives the radius kl, for the arc lm, and the circle C, representing the top of the frustum, is reproduced at F.

In developing the surface of pyramidal objects, it must be remembered that the slant height is the *true altitude* of one triangular face. (See Fig. 12.) Having drawn *hi* equal to *bc*, erect a perpendicular, *nk*, at *n* equal to the slant height of the object. *ki* is the radius for the arc *lnm*, upon which the width of the other faces may be set off. *E* corresponds to the base *B*, and in a frustum *F* corresponds to the square *C*.

For suggestions for placing laps see page 10, Book VIII.
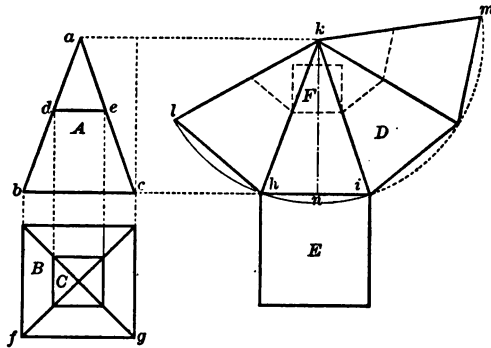
Fig. 12.

Laps. — Laps should never be added to those parts of a development which correspond to the bases or ends of prisms. Bases should always be bounded by a clean-cut, sharp edge. Go over lines representing edges with a pin, or lightly with the point of a knife, to insure sharp edges when folded. *Fold with the lines on the outside.*

Page 13. Radiating Flat, Truncated. —

a. Draw the margin lines.

b. Draw two views of a square or hexagonal pyramid or of a cone, or of a frustum of one of these, locating the axis 1¾″ from the left margin line. The side view should measure in each case 1¾″ wide and 3″ high. (See Ills. 17, 18, and 19.)

1. Develop the surface in the space at the right.

2. Draw the flat upon development paper and construct the object.

Page 14. Application. —

a. Draw the margin lines.

b. At the left, make a working drawing of the object to be constructed, — a cardbasket, pan, lampshade, or some similar object, illustrating the condition.   (See Ills. 20 and 21.)

1. Develop the surface at the right.
2. Upon development paper draw the flat and construct the object.

The Cardbasket. — The workbasket, or cardbasket, Ill. 20, may be drawn as follows : Draw the circle circumscribing the base. Within it inscribe the hexagon.   Upon one side of the hexagon as a base construct a pentagon.   Draw circles passing through the angles of the pentagon.   Draw the *diameters* of the hexagon, and extend them to intersect the largest circumscribing circle.   Locate the remaining points of the pentagons, by setting off the proper distances to left and right of the points where the extended diameters intersect the inner circle.

The Dishpan. — The pan, Ill. 21, is a simple frustum.

<div align="center">RESULTS.</div>

Drawings of developments must be accurate, otherwise the parts will not fold together perfectly.   The lines representing edges should be sharp and dark and of uniform strength; those representing the laps should be lighter.   Objects constructed from developments should be neat and accurate. These results can hardly be produced with poor material.

Encourage the pupils to make original applications or original modifications of selected objects, and original ornamentation of constructed objects.

Development should train the constructive imagination.

ILLUSTRATIONS.
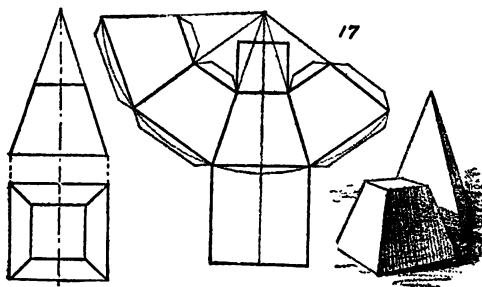
17. Flat of frustum of square
     pyramid.

18. Flat of frustum of hex-
    agonal pyramid.
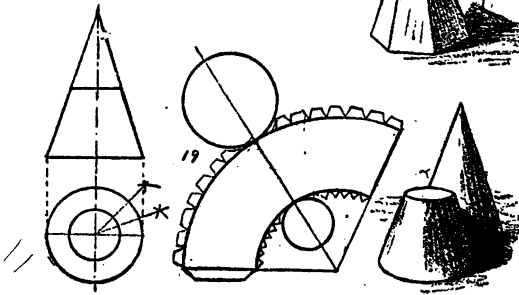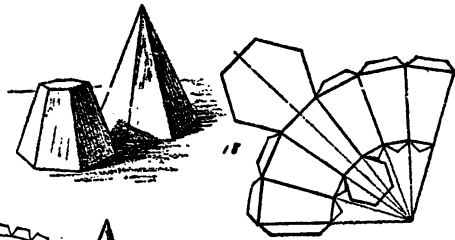
19. Flat of frustum of cone.
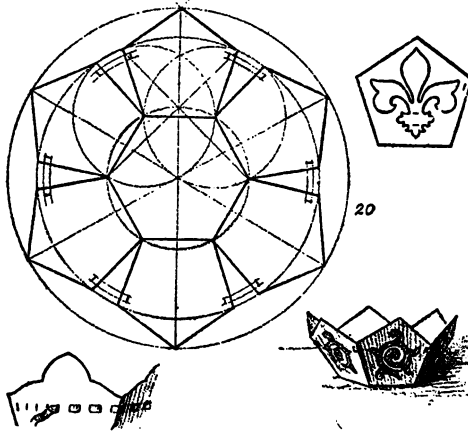
20. Flat of a cardbasket.

21. Flat of a pan.
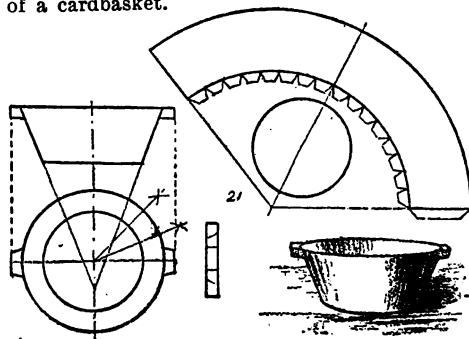
2. DECORATIVE DRAWING.

Decorative Drawing, as a subject, includes the study of those elements which inspire, guide, and enrich ornamental designs. The designer finds ideal types and guiding laws in *Historic Ornament*, and its derived principles of *Design*, inspiration and suggestion in *Plant Form*, and appropriate enrichment for his drawings in *Color*. Color is taken first, however, that the pupils may be prepared to observe and study it throughout the course in decorative drawing, and make practical use of it in historic ornament and design.

Decorative drawing, as drawing, should be beautiful. Everything which aids in producing an ideal result is therefore legitimate, — ruler, compasses, tracing paper, anything in its proper place.

V. COLOR.

The work of this grade in color presupposes a knowledge of the spectrum and its different selected tones, and the ability on the part of the pupils to recognize, match, and name in order, beginning at the top, at least the eighteen tones given in Fig. 13; also to name at sight the various tints and shades of each color. If these are not familiar, the pupil should begin with the work outlined for previous years.

COLOR HARMONIES.

When color tones are grouped so that they produce an effect pleasing to a cultivated color sense, they produce a harmony. Different groupings of tones produce different harmonies. Contrasted harmony was used in the primary grades, dominant harmony in the fourth and fifth years, and complementary harmony in the sixth year. This year the study of *analogous* harmony is to be continued.

TINTS		KEY TONES	SHADES	
2	1	Violet-red.	1	2
		Red.		
		Orange-red.		
		Red-orange.		
		Orange.		
		Yellow-orange.		
		Orange-yellow.		
		Yellow.		
		Green-yellow.		
		Yellow-green.		
		Green.		
		Blue-green.		
		Green-blue.		
		Blue.		
		Violet-blue.		
		Blue-violet.		
		Violet.		
		Red-violet.		

Fig. 13.

Contrasted Harmony. — The pale yellow or yellow-orange of the moon against the gray-blue of the sky, or the reflection of the moon in the green-gray water, are instances of contrasted harmony. Other natural examples of it are found in the coloring of the cedar bird, with the touch of luminous red in its gray plumage; the redcup lichens growing upon the gray rock; the cardinal flower seen against the dark background of almost invisible green; the lily of the valley with its pure white against the protecting green leaves, which have much subduing

gray in their darker shades; the trees in the spring with their delicate green against the gray bark of the trunks and the gray sky; and the trees in autumn with their brilliant yellow, orange, red, and brown foliage against the cold gray sky, green weeds and grasses growing in the crevices of old stone walls; the brilliant algæ in the gray-green of the water, broken by motion into many variations of tone.   These are but a few of the innumerable harmonies of contrast that may be found on every side in nature.

In design, any single color against a gray background always gives this harmony.   This is why judicious mounting always improves the effect of a design.   In general, the warm colors — from red to yellow-green — are improved by being mounted on a cool gray background; while the cool colors — from green to violet — are improved by being mounted on a warm background.

Dominant Harmony. — Dominant harmony is produced by using the tones of a scale of color, or a part of them, arranged according to their values.   It may be illustrated by arrangements consisting of two tints and the standard, two shades and the standard, or the tints and shades of any one color.   Varied effects may be produced by changing the order of the tones used.   Thus, the standard may be used for the background and the two tints or two shades in the design, or one of the tints or shades for the background and the other tint or shade and the standard in the design.

Although the harmonies of contrast are brilliant and pleasing when the tones of the contrasting colors are not too dissimilar, yet the finest blendings of colors, affording in every case the quietest, the purest, and, all things considered, the most satisfactory harmony, are produced by dominant harmonies.

On account of the quiet influence of these combinations in establishing in the minds of the pupils a pure taste for color, while contrasting colors, if used too early, are apt to vitiate the taste, all the earlier work in color arrangements and design

should be with the tones of one color; no two colors, unless gray is one of them, should be used in the same design. In such arrangements, with tones selected from one color scale, there can never be any discordant tone, as is apt to be the case when colors are selected from different color scales and arranged together. These latter arrangements, — contrasted, analogous, and perfected harmonies, — require careful judgment and a trained color sense to avoid discordant tones.

Complementary Harmony. — This harmony is produced by combining tones from complementary scales. As color tones change with every change of light, and as colors are perfectly complementary only when combined in certain proportions, it is best, when using colored papers, to add white, gray, or black to mediate between them ; for the tones of the paper, owing to changes in illumination and to imperfect distribution in the design, seldom produce satisfactory effects unless qualified by a neutral.

There are three methods of accomplishing this : —

1. To use tones of pure color separated by gray or white, as in Fig. 14.
2. To use several tones of one color, modified by black or white (dominant harmony), with a small amount of one tone from the complementary scale, as in Fig. 15.

| G Y | W | V |

Fig. 14.

BGt² *Rt²* *BGs²*

Fig 15.

A-YOt *A-YOs* *Bt²*
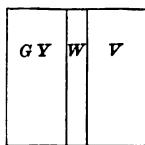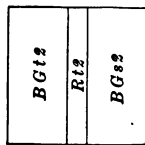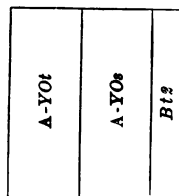
Fig. 16.

3. To use tones from the broken scales, illuminated with bits of pure color, as in Fig. 16.

Analogous Harmony. — This harmony is produced by combining tones from neighboring scales. To produce the best

results, the tones must be selected from scales which are very closely related. Various groupings of tones may produce pleasing analogous harmonies; but as a rule they all follow one law, — a predominating tone with variations from this

YOs2	YOs1	YO	YOt1	YOt2
OYs2	OYs1	OY	OYt1	OYt2
Ys2	Ys1	Y	Yt1	Yt2
GYs2	GYs1	GY	GYt1	GYt2
YGs2	YGs1	YG	YGt1	YGt2
Gs2	Gs1	G	Gt1	Gt2

Fig. 17.

toward the standard next above upon one side and toward that next below upon the other. (See Fig. 17.) The following combinations also illustrate analogous harmony : —

Gt2,	YGt2,	GYt2,	Yt2,	OYt2.
Gt2,	YGt1,	GY,	Yt1,	OYt2.
Gt2,	YGt1,	GY,	Ys1,	OYs2.
YGt2,	GYt1,	Y,	GYs1,	YGs2.

These are selected to illustrate the typical movements through the scales. The possible combinations are almost without limit

Fine illustrations of analogous harmonies of color are to be found in almost every natural object. Any pebble or metal-bearing mineral (as virgin copper, cuprite, etc.), the clouds, the plants, the plumage of birds (notably of doves. humming birds, parrots, canaries, and peacocks), and the coverings of beasts, often exhibit exquisite combinations of analogous colors.

In nature, the analogous scale is often extended to include an infinite number of hues between tones as distant in the spectrum as red and blue (through violet), or yellow and blue

(through green). In flowers, the following series is often found: Y, GY, YG, B, BG. Lead the children to discover and enjoy these delicate harmonies.

In art, perhaps some of the best analogous harmonies yet produced are to be found in the vases and wall decorations of the Greeks.

As the end to be secured is beauty, a copy of a good harmony is preferable to an inharmonious result, though original.

MATERIALS.

The materials for color work must be carefully protected from light, except when in actual use, and should be handled delicately, so that no finger marks or wrinkles disfigure the paper.

Tablets. — The teacher and each pupil should be supplied with the set of color tablets, especially prepared for use in the seventh year grade.

Papers. — Each teacher should be supplied with at least one package of the colored papers for the seventh year grade.

Other materials are such as have been used already in geometric drawing.

METHODS.

Preparation. — All exercises in color should be worked out by the teacher previous to the lesson. It would be well to use large tablets, so that the completed exercises may form charts for class use.

LESSONS.

Preliminary Work. —

a. Review the work in color of previous years. This may consist of the recognition, matching, and naming of each of the six standard spectrum colors: red, orange, yellow, green, blue, and violet; and the hues: violet-red, orange-red, red-orange, yellow-orange, orange-yellow, green-yellow,

yellow-green, blue-green, green-blue, violet-blue, blue-violet, and red-violet, and all their tints and shades.

Review the work of the sixth year, — classification by composition.

b. Review the work of the seventh year, — analogous colors. Analyze natural objects for their color, and match the tones with the papers.

c. Teach *classification by qualities, — warm, cool.*

d. Teach the *effects of juxtaposition.*

Quality. — Quality is the character of a color relatively considered.

The spectrum colors, when compared with one another, may be easily divided into two classes, called by artists "warm colors" and "cool colors."

The reds, oranges, and yellows are called *warm* colors because of their resemblance to the colors of flame. The others are called *cool* colors, by contrast. The ocean is blue when seen from a distance. A heap of ice has a deep green hue; these colors are found in the cool part of the spectrum.

The terms *warm* and *cool*, are, however, merely relative, for when violet is compared with blue it appears redder than blue, or, as artists say, warmer than blue. The quality of violet may be changed by the addition of a warm color like red. Red-violet illustrates this. Violet is a cooler color than this red-violet. Yellow-green is warm when compared with green, but cool when compared with orange-yellow.

Effects of Juxtaposition. — Besides these *natural* qualities, colors may *acquire* or *impart* certain qualities. For example, a neutral gray spot on orange appears cool gray or even a tint of green-blue; while upon green-blue the neutral gray spot will appear warm gray.

Those tones of the spectrum which affect other tones readily are called positive, or, more accurately, *active* colors.

Those tones which are easily affected are called negative, or, better, *passive* colors.

The tones not found in the spectrum (namely, white, the grays, and black) may be called the passive colors, and those tones found in the spectrum may be called the active colors. But these are relative terms also, for some of the spectrum colors are more active than others, and tints and shades sometimes receive qualities as readily as grays.

Drill Exercises. — Have pupils select from papers and other colored objects a warm green and a cool green, a warm blue and a cool blue, a warm violet and a cool violet, etc. Compare the greens of leaves, the violets of asters, etc. Compare the grays of tree trunks, of pebbles, of clouds.

Cut 2″ squares of various colors and place $\frac{1}{2}$″ squares of neutral gray upon them. Substitute $\frac{1}{2}$″ squares of warm gray; $\frac{1}{2}$″ squares of cool gray. Determine the most active standard; the most passive gray. What changes in quality occur?

Select two active colors which will make a warm gray appear neutral, and two which will make a cool gray appear neutral. Select two active colors which will make a neutral gray appear warm, and two more which will make it appear cool.

Page 23. Effects of Juxtaposition. —

a. Draw margin lines.
b. Lay out the page as indicated in Fig. 18.
c. Cut out the figure from colored papers as indicated. The circles *d* and *e* should be $\frac{3}{8}$″ in diameter; *d′* and *e′*, 3″ in diameter; and the white circles $2\frac{1}{2}$″ in diameter. When completed *d* will appear nearly like *c*, and *e* nearly like *f*, *g* and *h* will show the grays unaffected by juxtaposition with active colors. The larger squares are $1\frac{1}{4}$″, the smaller are $\frac{1}{2}$″. The rosettes need not be exactly like those in the diagram, but the diameter should be $1\frac{1}{4}$″. The others may be made of any appropriate size.

1. Arrange the papers upon the page and fasten them in position.

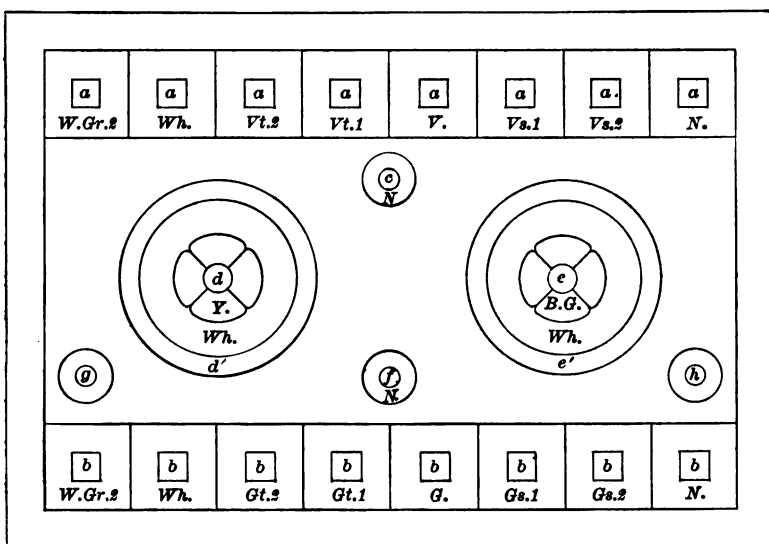For application of color to design, see under Paper Cutting.

Fig. 18.

a. Warm gray No. 1 on gray, white, violet scale, and black.

b. Warm gray No. 1 on gray, white, green scale, and black.

c. Cool gray No. 2 on black.

d. Neutral gray No. 1. *d'* the same.

e. Neutral gray No. 1. *e'* the same.

f. Warm gray No. 2 on black.

g. Neutral gray No. 1 on cool gray No. 2.

h. Neutral gray No. 1 on warm gray No. 2.

Y. Yellow flower form.

BG. Blue-green flower form.

RESULTS.

Only final results are to be preserved in the book. These should show accurate cutting and no finger marks.

When it is desirable to inclose the color diagrams with margin lines, the pencil outlines should be soft and dark.

The pupil should acquire a love for pure, harmonious coloring.

VI. HISTORIC ORNAMENT.

Historic Ornament includes the study and representation of those examples of decorative design which have been preserved from the works of ancient and mediæval artists.

A group of artists whose work is similar in its inception or expression forms a *school.* This term is also applied to the results of the coöperation of such a group of artists. The different schools may be distinguished by certain characteristics; and all ornament usually studied by modern designers is divided, according to these distinguishing marks, into six groups, schools, or styles, namely: —

Three Ancient Schools, — Egyptian, Greek, Roman.
Three Mediæval Schools, — Byzantine, Saracenic, Gothic.

The subject begins, in this grade, with simple units chosen from different schools to illustrate conventional plant forms on balanced main lines.

MATERIALS.

The ornaments for study are found in Drawing Book VIII., pages 15 and 16, and they may be supplemented by drawings from books on ornament and photographs of historic architecture. Such works may be found and consulted in the public library.

Pencil, Paper, Scissors, etc. — As previously described.

METHODS.

Preparation. — The teacher, to do the best work, should be familiar with the outline of the history of ornament (Wornum's "Analysis of Ornament" is a standard work), and with the interesting details of the history of common units like the lotus, the wave scroll, the fret, the lily, and the acanthus, as well as the various crosses and symbols used in the different schools. Such information cannot be gathered from any one book, but must be obtained by general reading on historical subjects connected with art. But for giving the lessons here outlined, a careful study of the notes on the illustrations will enable the teacher to obtain good results.

Fig. 19.

Preliminary Work.—The review may consist of a study of such illustrations as the following, sketched upon the blackboard:—

Fig. 19. Byzantine frieze, combining foliage and ribbon ornament.

Fig. 20. A corbel, or basket-like bracket, used in Byzantine and Gothic architecture.

Fig. 21. An illustration of Byzantine stone sculpture of the eleventh century, from St. Mark's, Venice. It is a well-
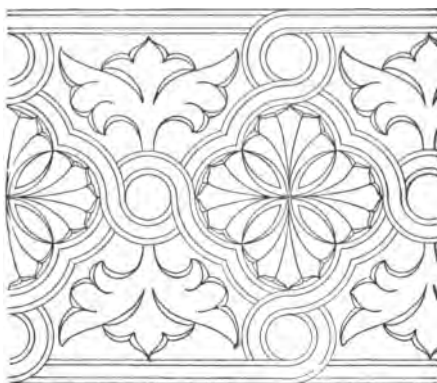

Fig. 20.

marked example of Byzantine interlaced curves.

Fig. 22. Roman anthemion border. In general, this strongly resembles the Greek anthemion border, but the elements are distinctly Roman.

Have the pupils sketch the main lines of these, and compare them with other examples from the same countries, found in the Drawing Books.

Fig. 21.

(a) In teaching *balance,* use the illustrations in the Drawing Book. Lead the pupils to see that while oppo-

Fig. 22.

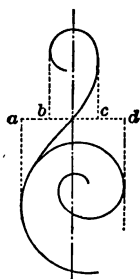site sides of these ornaments do not correspond, there appears to be an *equal weight* upon each side of the axis. This distribution of parts produces *balance*. Balance is most obvious in main lines. The law which governs the arrangement of parts may be illustrated by Fig. 23. The curves, though varying greatly in character, extend equally to left and right of the axis. Force upon one side is balanced by force upon the other. Grace is often embodied in a single reversed curve properly balanced as in Fig. 24, and some of the most beautiful historic forms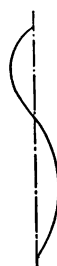 are composed of these curves. For example, in Fig. 25 (a Roman acanthus scroll from the Forum of Trajan), the outer leaves are grouped upon three repetitions of the curve *abc*, Fig. 26; the smaller upon three repetitions of *dbe*, and the central husk is upon the curve *bfg*.

Fig. 23.

Fig. 24.

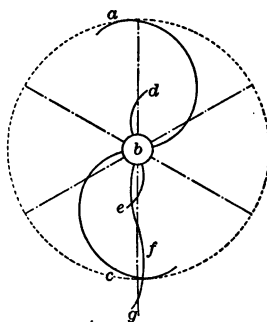(*b*) Sketch the main lines of the examples given on page 16, a few of which are shown in Fig. 27. Notice that the general tendency is radiation from a point, and that the curves, though continued, do not intersect one another in such a way as to appear confused.
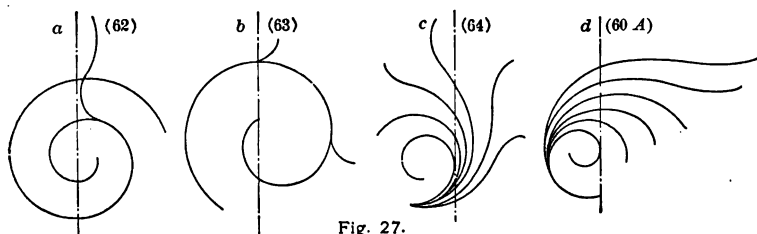
Fig. 25.

Fig. 26.

a (62) *b* (63) *c* (64) *d* (60 *A*)

Fig. 27.

Page 17.   Conventional Plant Form on Balanced Main Lines. —

a. Draw margin lines.

1. Select one of the illustrations on the right half of page 16,
     and draw it enlarged up⌐ ι the left half of the page.
2. Select one of the illustratiᵤs on page 15, and reproduce it
     upon the right half of the page. (Fold page 15, so that
     the selected form will be in view while drawing.)

Enlarging. — Compare the width and height of the figure to
be enlarged with the width and height of the page.   Deter-
mine the scale upon which the figure is to be enlarged, by
comparing the widths and heights, remembering that the en-
larged figure must have the same relative width and height as
the original.   Sketch the axis of the figure.   Locate its impor-
tant main lines and masses.   Test the correctness of these parts.
Sketch the details.   Correct.   Finish.

RESULTS.

The drawings should be as large as
the allotted space will allow, accurately
proportioned, with good curves, and soft,
gray lines, — ideals of decorative form.

The pupil should soon acquire an ap-
preciation for simple, well-constructed
forms of chaste outline.

ILLUSTRATIONS.

57. Greek ornament. It is found on the borders
      of vases now in the British Museum and
      at the Louvre.   The vases are in two
      colors, the design being in red and the
      background in black.   The design de-
      pends for its effect upon pure form only.
      The leaves, arranged in the form of pal-
      mettes, spring from a curved stem, each
      radiating from the center of its group, and
      diminishing, in exquisite proportions, as it

57

approaches the center. The stems have graceful volutes at the ends, and all the lines grow out of the parent stem in tangential curves.

Some authorities think the forms are derived from the honeysuckle and lily, others from the palmetto and lotus; while others believe that the units are simply combinations of brush marks illustrating the three general laws reigning in plant life, — radiation from the parent stem, proportionate distribution of areas, and tangential union of lines.

58. A Roman ornament, representing an acanthus husk or external covering of the fruit or seed of the acanthus. (The Romans used the *acanthus mollis*, or soft acanthus.) The example is taken from fragments of sculpture in the Villa Medici, Rome. The acanthus is the parent of nearly all the subsequent styles of decorative foliage down to the early English Gothic. But for the spiral stem and overlapping parts this ornament would be bi-symmetrical.

58
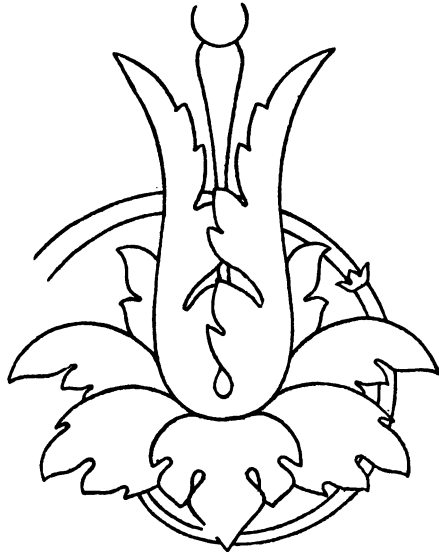
59. Egyptian, taken from decorative painting. This undulating frieze or ornament formed the basis of the Greek Vitruvian Scroll. The illustration represents the side view and front view of the lotus; the element of the spiral (derived, perhaps, from the long, flexible stems of the water lily) forms a strong basis of construction in this design.

60 (*a* and *b*). These decorations are Byzantine, and are taken from a curious manuscript in the National Library of Spain.

59

60*a*

60*b*

61. A grotesque animal form taken from a stone string course of the Gothic style.

62. Saracenic ornament, taken from the paneling of the center recess of one of the rooms of the Hall of the Ambassadors in the Alhambra. The curves of the decoration are beautiful, with proportions so fine that it is difficult to determine them.

63. A Gothic specimen of painted glass of the fourteenth century, from the church at Altenburg, near Cologne.

64. An ornament of the Gothic style of the fourteenth century. One of the most beautiful features of the Early English style is that the ornament is kept in perfect relation to the form which it decorates. This is a specimen of stained glass from St. Thomas, at Strasburg.

VII. BOTANICAL DRAWING.

Botanical Drawing includes the study and representation of plant form, as related to ornament and design.

MATERIALS.

Objects. — These should be collected by the pupils under the supervision of the teacher. In this grade they include sprays of common plants.

Pencils. — For botanical drawing, the pencils should be of medium softness, — a No. 2, or F, — and sharpened to a rather blunt conical point, that the delicate outlines of the selected forms may be appropriately represented.

Other materials required are like those already mentioned in other divisions.

METHODS.

Preparation. — The teacher should direct the pupils in the collection of sprays appropriate for the lessons. A lesson on the character of sprays will guide them in selecting.

If necessary, the sprays may be kept for a day or two in water or moist cotton, or best in a tight tin box placed in a cellar or some other cool place.

Sprays. — A fresh spray from almost any common plant contains beautiful lines of composition. The whole is often well balanced, and each smaller mass is pleasing in itself, and related to all the others and to the whole by the most subtle laws of growth. Each leaflet is placed upon its twig with some regard to all the others near it. The drawing of a spray is more complicated than any previously required of the pupil, but not difficult if the proper order is preserved.
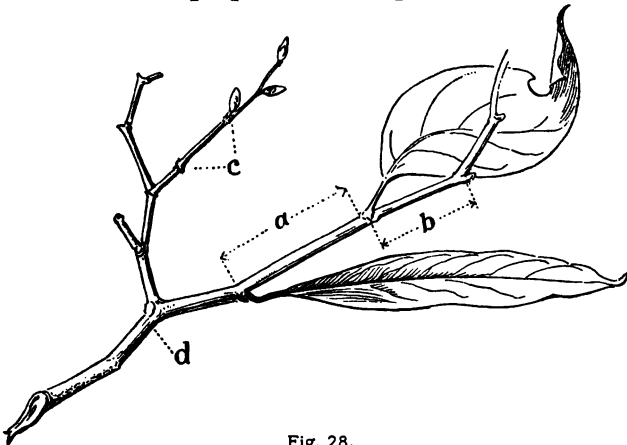
Fig. 28. Fig. 29.

Two classes of details will demand special attention, namely, twigs and joints.

Well-developed twigs and branches never taper. Between joints and leaf-scars each part is cylindrical (see *a*, *b*, etc., in

Fig. 28). Lead the pupils to discover and test this fact, and to illustrate it in drawings. New shoots (undeveloped branches) sometimes taper, and thorns (arrested or imperfectly developed twigs) always do.

Joints do not occur in nature as shown in Fig. 29, although usually so represented in sketches of plants and trees. At each joint, nature takes pains to strengthen the angle by means of buttresses and fillets, and these should not be ignored by the artist. (See *c* and *d*, Fig. 28.)

LESSONS.

(See Drawing Book VIII., pages 21 and 22.)

Preliminary Work. — In collecting sprays do not limit the pupils to those kinds illustrated in the Drawing Book. Use the plants which can be most readily obtained by the children; but select, if possible, graceful plants, having quite conspicuous flowers.

Sprays may be studied and drawn in the following order: —

> *a.* Study the character of the specimen. (Is it stiff and rigid, or delicate and graceful ?)
> *b.* Sketch its main lines.
> *c.* Sketch its entire mass.
> *d.* Sketch lightly the principal subdivisions of the mass.
> *e.* Sketch the leaves and twigs.
> *f.* Draw accurately, making each leaf a careful study.
> *g.* Finish. Nearer leaves may be made more distinct than those in the background. Dark touches may be made where twigs join stems. The lines used should express the character of the plant.

Page 18. Natural Forms. —

> *a.* Select the specimen.
> *b.* Plan the page, so that the spray may appear gracefully arranged.
> *c.* Draw margin lines if desired.
> 1. Draw, from nature, a spray of some graceful plant having leaves and buds, quite conspicuous flowers, or fruits.

The results should be truthful. Every line should have a meaning and character of its own. The drawing should represent the object as it appears, not conventionally. See illustrations in Book VIII., pages 21 and 22, for " handling."

The *ideal* drawing is perfect in form, delicate in handling, untouched by an eraser.

Botanical drawing should lead to a love for the delicate and beautiful in nature.

ILLUSTRATIONS.

49. Clematis. A climbing perennial herb, or vine, with long, slender branches, having a slightly woody stem, and climbing by the bending, or clasping, of the leaf stalks. It commonly grows on river banks and roadsides, climbing over trees and shrubs. The leaves are opposite, divided into three

obovate, acute leaflets, lobed and notched and somewhat heart-shaped at their base. The flowers are small and white, or yellowish white; petals, none, or small; sepals four; achenes numerous in the head, bearing the persistent styles; anthers, short and blunt.

50. Crane's-bill. This is an herb,

common in open woods and fields. Root-stock perennial ; stems erect, forked, and hairy ; leaves five-parted, each division being wedge-shaped, lobed, and cut at the end. Sepals slender, pointed ; petals entire, and of light purple. The long, fruit-bearing pod is thought to resemble the beak of a crane.

104 *A*. The wild columbine. This is a common perennial herb, found in rocky places near woodlands. It is erect and branching, with two to three ternately compound leaves ; the leaflets are lobed and notched. The flowers terminate the branches, are large, showy, and nodding. The stalk becomes upright in the fruit. The flowers are about 2″ long, scarlet and yellow inside, rarely yellow all over. Sepals five, regular, and colored like the petals. Petals five, all alike, with short spreading lips produced backwards into large hollow spurs. Pistils five, with slender styles.

104 *B*. Green brier. This plant is a shrub or herb, climbing, or supported by a pair of tendrils on the petioles of the leaves. Leaves, simple, ovate, ribbed, and netted-veined. The flowers are on umbels, and are small, and greenish or yellowish. The fruit is a small berry.

104 *C*. Bittersweet. A climbing shrub with three-parted, ovate, heart-shaped leaves, the upper leaflet being halberd-shaped, with two ear-like lobes or leaflets at base ; flowers purple or blue, in small cymes ; berries, oval and red.

Other plants which may be chosen for study because particularly well adapted for conventional treatment and design in sprays are the anemone, buttercup, poppy, watercress, nasturtium, bird's-foot violet, common St. John's-wort, common flax, maple, clover, pea, cherry, blackberry, wild strawberry, cinquefoil, hawthorn,

syringa, wild black currant, passion flower, honeysuckle, bluets (Houstonia), partridge berry, valerian, whiteweed, succory or chicory, dandelion, trailing arbutus, pipsissewa.

VIII. DESIGN.

Design, as a subject, includes the study of designs (whether historic or modern) to determine their structure, their laws and principles, and their form; the modification of geometric figures and the conventionalization of plant forms for units of design; and the creation and expression of arrangements of ornamental forms, according to recognized rules.

LAWS.

There are three great laws of arrangement; namely, *repetition, alternation,* and *symmetry.* In addition, there is one great law governing all arrangements making use of plant forms; namely, *growth,* — the natural dependence of parts. These laws are fundamental and unchangeable.

PRINCIPLES.

There are also certain other rules to be observed, called *principles of design.* These have been evolved through comparison of ornamental designs of different schools and times, and serve to guide the designer in his work. The following principles of design were studied by the pupils in the previous years, and should be reviewed this year: *Contrast, unity, strength, variety, rhythm, repose.*
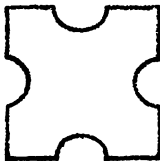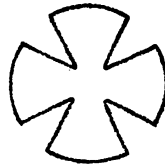
Fig. 30.   Fig. 31.

1. Contrast — *the proper opposition of parts.* — *Contrast of line* is produced when curved and straight lines are opposed to one another or succeed each other agreeably, as in Figs. 30 and 31.

Contrast of form is produced when masses of one kind are opposed to, or succeed those of, another, as in Figs. 32 and 33. In Fig. 32, the rounded lobe contrasts with the acute sinus; in Fig. 33, the pointed lobe with the rounded sinus.
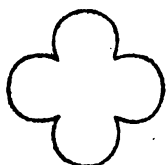
Fig. 32.
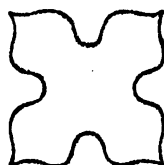
Fig. 33.

2. Unity — *the proper subordination of parts.* — Figs. 30, 31, 32, and 33 illustrate this principle. The lobes are subordinated to the mass; that is, each figure appears to be a *unit*. But Figs. 34 and 35 appear to be aggregations of units instead of single units modified.
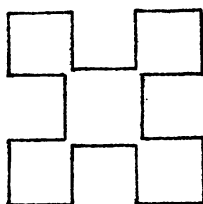
Fig. 34.
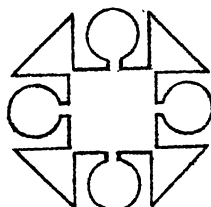
Fig. 35.

3. Strength — *the proper union of parts.* — Figs. 30, 31, 32, and 33 illustrate strength, the lobes being well held together; Figs. 34 and 35 show weakness, for the parts seem to have very inadequate
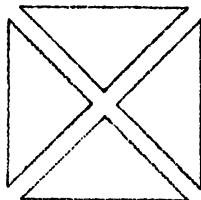
Fig. 36.
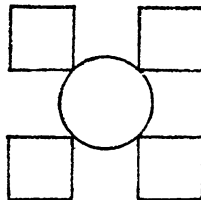
Fig. 37.

support. Perhaps the most flagrant violations of this principle are to be found in such designs as Figs. 36 and 37, where the parts are either not united at all, or merely by points.

4. Variety — *the proper difference of parts.* — Contrast may exist between two kinds of things; variety, between two things of the same kind. A group containing circles, squares, and triangles shows contrast; a group of scalene, equilateral, and obtuse-angled triangles shows variety. Fig. 38 shows contrast, but no variety, — any section
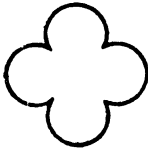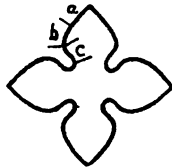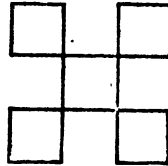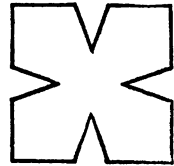

Fig. 38.　　　　Fig. 39.　　　　Fig. 40.　　　　Fig. 41.

from any curve would be just like any other; but in Fig. 39 is variety, the section of the curve *a* being different from *b*, and both different from *c*. In Fig. 40 there is no variety, all the lines being equal. Fig. 41 shows variety, — all of the lines are straight, but of different lengths.

Fig. 42.　　　　　　　　Fig. 43.

5. Rhythm — *the proper recurrence of parts; repetition with accent.* — Fig. 42 shows mere repetition; Fig. 43 has rhythm. In a bilateral unit, Fig. 44 corresponds to Fig. 42, while Fig. 45 has rhythm, and
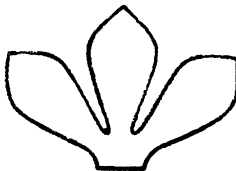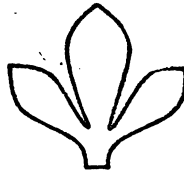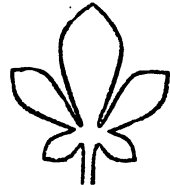

Fig. 44.　　　　　　　　Fig. 45.　　　　　　　　Fig. 46.

Fig. 46 has it more perfectly. Rhythm may, then, be produced by the recurrence of similar parts of different sizes.

6. Repose — *the proper correlation or grouping of parts.* —In Figs. 47 and 49, each unit by itself is not bad, but, when grouped, the whole appears stiff, and each seems to care more for itself than for the design as a whole; each is selfish, having no interest in the good of all. But in Figs. 48 and 50, each helps all, and all each, to make a
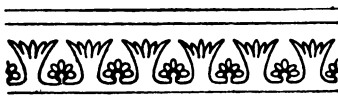

Fig. 47.

Fig. 48.

pleasing whole. The parts work together in groups. In Fig. 48, the curve 1–2–3 is repeated by the curve suggested by the ends of the petals, again by the curves 4–5–6, and 4–7–8–9, each harmoniously relating smaller groups of parts; and these largest curves, overlapping, join all into one unity. In Fig. 50, a loop is thrown out from A through 1, another from A through 2, and still another is suggested from A through 3 and 4. All the lobes, 3, 4,
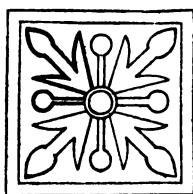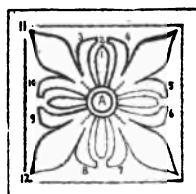

Fig. 49.

Fig. 50.

5, 6, etc., fall into a circle similar to A, and those on one side, 11, 10, 9, 12, suggest a double reversed curve swinging from one corner of the square to another, each lobe furnishing its part. One is never sure of the value of a unit until it is seen in its relation to others.

NOTE. — These principles may be forcibly illustrated by folding and cutting paper units similar to those illustrated in Figs. 30 to 50.

The materials are such as have already been described under
Historic Ornament, and in addition the illustrations in Draw-
ing Book VIII., pages 27 and 28. A few designs constructed
from colored paper will be found helpful in stimulating the
interest of pupils.

Preparation. — The teacher should be familiar with the laws
and principles of design, and with the processes to be taught.
All exercises in design should be worked out by the teacher
previous to the lesson. It would be well to work them on a
large scale, that the completed exercises may form charts for
class use.

Half-tinting. — Half-tinting is often used in design to give
clearness and relief to the figures. Half-tinting may be either
mechanical or freehand. If mechanical, the lines should be
fine, clear, equidistant, and apparently continuous over the
surface of the ground or field. If freehand, the lines should
be fine, distinct, broken lines, approximately equidistant.
In either case the half-tinting, when held at arm's length,
should give the effect of an even gray tint over the portions of
the field not covered by the units of design.

A design which, in outline, appears weak and insufficient to
cover the field properly, may sometimes be strengthened by
half-tinting it instead of the field. (See Ills. 120 and 121.)

Tracing. — In designs where units are to be repeated, after
half a unit is drawn lay a piece of tough tissue paper, or,
better, genuine tracing paper or tracing cloth, over the unit,
and trace the outline with a well-pointed and rather soft
pencil. Place dots on the tracing paper indicating extreme
points of the axis of the unit, to assist in correctly placing the
tracing upon the other side. Fit the tracing *drawn side down,*

upon the other side, and go over the outline again.   Repeat
for other units, reversing the tracing paper each time.   Entire
units may be traced and transferred in a similar manner.

When a tracing cannot be reversed, blacken the under side
of the tracing paper by going over it with a soft lead pencil,
and place it, blackened side down, in the proper position.   Go
over the lines of the drawing with a hard pencil.   This will
leave an impression of the drawing on the page.

<div align="center">LESSONS.</div>

<div align="center">(See Drawing Book VIII., pages 22, 27, and 28.)</div>

Preliminary Work. — A preliminary review may consist of a
study of the illustrations in Book VIII., somewhat as fol-
lows : —

What parts of Ill. 57, page 15, are bilateral?   How could
Ill. 58 be made bisymmetrical?   Sketch the main lines of Ill.
60 *A*.   Select all the bisymmetrical forms from the conventional
details on page 22.

    a. Review Historic Ornament, giving special attention to the *law
of balance*, as manifested in the examples given on pages
15 and 16.   Study the illustrations on pages 27 and 28.
These show applications of the same law.

    Review bilateral main lines and conventionalization.

    In conventionalization give special attention to the correlation
of parts, as shown in Ill. 116, page 28.

    b. Study the balanced main lines given on page 28.   Notice the
subtle radiation and tangential union of all the parts.
Notice the *growth*.

    c. Practice clothing main lines with floral units, to illustrate the
principles of design.

Page 19.   Conventional Details. —

a. Draw margin lines.

b. Plan the page.

1. Conventionalize the natural forms drawn on page 18.

2. Draw an arrangement of balanced main lines similar to Ill.
111, 112, 113, or 115, page 28.

Page 26.   Design from Copy. —

1. Copy Ill. 122, page 27, enlarged to properly fill the space.

Page 25.   Original Design. —

a. Sketch an original design, on balanced main lines, using the conventional details drawn upon page 19, and an inclosing form similar to Ill. 118 or 119.

1. Draw the original design in the Drawing Book.

Original Design. — An original design is simply the result of the pupil's own thinking, and need not, necessarily, differ in all its details from any other design. If the following steps are observed, every pupil can produce creditable work: —

a. Decide upon the kind of design to be made — border, surface, or center.

b. Sketch the inclosing form or field for the design.

c. Sketch the main lines, remembering that they must have a proper growth, radiation, and tangency.

d. Clothe them with the conventional units, bearing in mind the following points: —

    1. A proper arrangement of parts. The *growth* must be orderly. Each part must have an evident and natural source of growth. Leaves should not appear to grow from leaves, nor flowers from leaves or from other flowers.

    2. A proper balance of parts. To secure this, the important masses of the design must be arranged on a symmetrical basis, whether the design is bisymmetric or otherwise.

    3. A proper distribution of parts. As a rule, good judgment will be a sufficient guide in the disposition of the elements of a design. They should be so distributed as to form a well-balanced whole, constructed and arranged in such a manner as to produce an harmonious effect. To this end care must be taken that the field of the design shall not be too crowded with decoration in one part and too open in another, but that evenness and balance shall be preserved throughout.

e. Correct and finish.

As the end to be secured is beauty, ruler, compasses, tracing paper, or any other means which will aid the pupil, is legitimate.
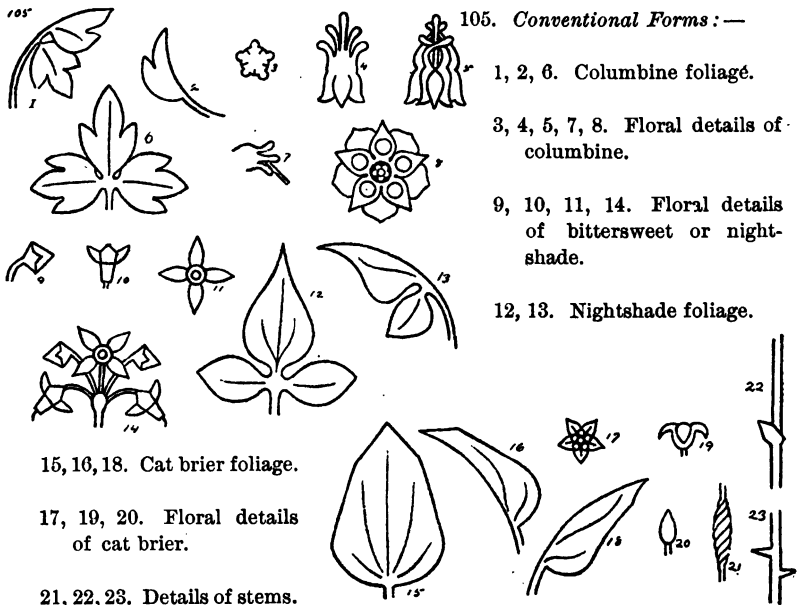
RESULTS.

The original designs may be considered good at this stage, if they do not violate a principle of design and are well drawn or accurately cut.

Complicated designs are not to be required nor encouraged. A few well-placed main lines, in which the principles of growth and radiation are observed ; a few carefully studied units, beautiful in outline, and symmetrically placed, with a regard for the principles of variety, rhythm, repose, etc., will give a more chaste and pleasing design than will a great variety of forms thoughtlessly combined, or drawn with painful precision on deformed main lines.

The drawings should be clean and clear, and finished in delicate gray lines.

Design should develop taste and originality.

ILLUSTRATIONS.

105. *Conventional Forms :* —

1, 2, 6. Columbine foliage.

3, 4, 5, 7, 8. Floral details of columbine.

9, 10, 11, 14. Floral details of bittersweet or nightshade.

12, 13. Nightshade foliage.

15, 16, 18. Cat brier foliage.

17, 19, 20. Floral details of cat brier.

21, 22, 23. Details of stems.

106, 107, 108. Balanced main lines adapted to borders.
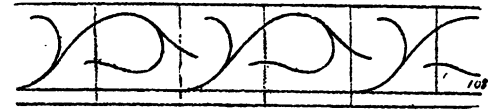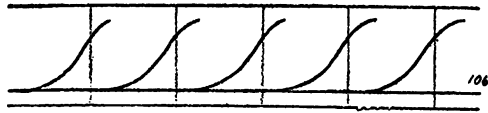
109. Border of ivy leaves.

Take
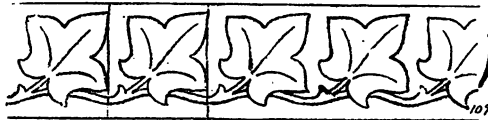
110. Border from the goldthread.

111, 112, 113, 115. Balanced main lines.
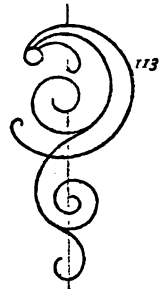
114. Sprouting ferns, showing balanced main lines in nature.

116. A crowfoot leaf, balanced and massed to produce repose, arising from correlation of parts.
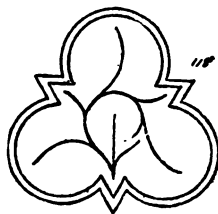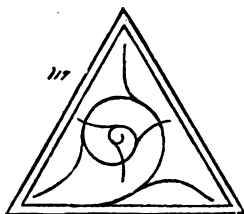
117. Balanced main lines in an equilateral triangle.
118. Balanced main lines in an ornamental trefoil.

119. Balanced spray of morning glory in an ornamental panel.
122. Balanced design for a tympanum, from the water crowfoot.

120, 121. Illustrations of effects produced by half-tinting.

IX. PAPER CUTTING.

Paper Cutting includes the making of units of design or other ornamental details, for use in constructing designs of colored paper.   It is an elementary form of applied design, and may illustrate the essential principles of good design for surface decorations, such as ceiling patterns, wall papers, and carpets.

PRINCIPLES.

The essential principles to be observed in work of this character are: —

1. Flatness. — Surfaces which are to be used as backgrounds for pictures, furniture, etc., should not be so ornamented that their apparent flatness is destroyed.   Perspective effects or the appearance of high relief are entirely out of place.

2. Equable Distribution of Masses. — Irregular or large uncovered portions of surface should not occur in the same pattern with closely placed units, unless the intention is to produce a stripe.   But pronounced stripes are out of place in floor coverings, and, as a rule, in wall or ceiling papers.   Stripes tend to lead the eye rapidly over the surface, and off it; the pattern should simply enrich the background without giving it prominence or making it obtrusive.

3. Harmonious Coloring. — The specially prepared colored papers furnish the very best means for the employment of harmonious coloring in elementary designs.

MATERIALS.

Paper. — For cutting patterns to be used in tracing other units, oak tag (used in making developments) is best.   For folding and cutting a number of thicknesses at once, the thin, soft, colored papers are best.   Thick or stiff papers do not fold closely.

For constructing designs, the colored papers put up in pack-
ages for this course, and known as WHITE'S, are best.

Scissors. — Sharp, steel scissors are best for this work. Cheap
iron scissors tear the paper instead of cutting it, and soon get
out of order.

Other materials are like those already used.

METHODS.

Preparation. — The teacher should work out all exercises
in paper cutting previous to the class lesson, to discover any
points of difficulty.

LESSONS.

Paper cutting should be taken in connection with work in
design and historic ornament.

In constructing bilateral designs, fold the sheet from which
the design is to be cut with the colored surface inside. Taking
the crease as the axis of the design, trace accurately one half
of the design upon the back of the sheet. Cut the margin and
then the figure, always holding the paper between the thumb and
fingers, as near as possible to the cutting point of the scissors.

When cutting a design of one color having an inclosing form
of another, the two sheets should be folded together and two
inclosing forms and two designs cut at the same time. This
will give the pupils an opportunity to experiment, and discover
which arrangement of the colors is most pleasing and effective.
The design, as finally constructed, may have the warmer color
for the figure and the cooler for the inclosing form, or *vice
versa.*

A knife may be used to advantage in some cases, especially if
the design is complex.

For methods of folding and cutting paper, see Manual for
Sixth Year. In that book will be found directions for making
a pattern, for cutting several units at once, and for cutting
radial designs of four, five, and six parts. These processes
should be carefully reviewed. A general rule, when making

a radial or bilateral design, is to fold the paper in such a manner that, by drawing upon it one half of the unit or of one of the radiating parts and cutting on the drawn lines, the required number of units or the many parted radial design will be the result.

A balanced design should be drawn accurately upon a sheet of thin, tough paper. Place this upon the colored sheet or sheets, and cut through all the sheets at once with a sharp-pointed knife.

Page 24. Design in Color. — No definite directions can be given for selecting the proper colors for this design. The taste of the pupil and teacher must be the guide. As a general rule, however, the colors chosen should not be from the spectrum standards and hues, but from their tints and shades. One color should be used for the field, one for the figure, and one for the inclosing form.

A good effect is sometimes produced by using a double inclosing form, one part an eighth of an inch larger on all sides, and of a different color from the other part. The two parts when combined in the design give the effect of a frame with an "insider," such as is often seen upon photographs and engravings.

Analogous colors may be used in the figure, and in the double inclosing form just described, upon a field of gray. Beautiful effects are often produced in this way.

Never cover the entire under-surface of a unit with glue; the design will not dry flat.

1. Construct either the original design, or Ill. 119 or 122, drawn upon page 25, using colored papers illustrating analogous harmony.

RESULTS.

The constructed design should be harmonious in color, accurately cut and spaced, and neatly constructed.

The end to be secured is beauty. Every means should be used to obtain an ideal result.
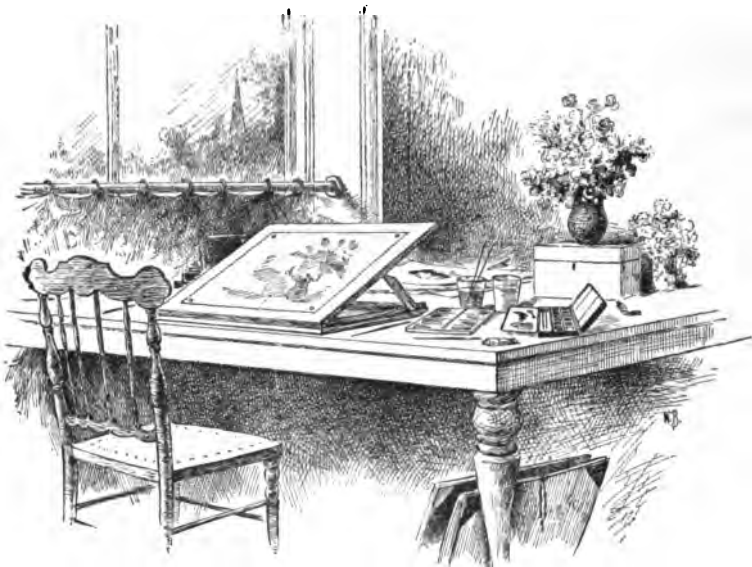
3. PICTORIAL DRAWING.

X. MODEL AND OBJECT DRAWING.

Pictorial Drawing includes the study and representation of objects as they appear to the eye from one point of view.

Type Solids. — The principles which govern the correct pictorial representation of objects may best be learned through the study of type solids, which lack perplexing details.

Applications. — When the principles are learned, they should be applied in the pictorial representation of: —

1. Objects similar to the type in form.
2. Groups of objects based on types.
3. Sketches from nature, — landscapes, etc., involving the principles derived from the study of the types.

MATERIALS.

Models. — Each pupil should be supplied with White's Drawing Models for advanced classes. During this year he will need a cube, a half-cube, a triangular prism, and a pyramid.

Objects. — Each pupil should be supplied with objects based on the type forms. For the first lessons, the objects should be alike if possible; that is, each pupil should have a book. But later, each pupil may select his own application.

Paper. — Manilla practice paper, $9'' \times 12''$, is best for first work.

Pencil. — The pencil should be of medium softness, — an F, or M, or No. 2, and sharpened to a rather blunt, conical point.

Wire. — A piece of wire or a knitting needle will be found very helpful in determining levels.

METHODS.

Preparation. — The teacher should work out each exercise before giving it as a class lesson, to insure easy and logical steps for the pupils.

LESSONS.

(See Drawing Book VIII., pages 29 and 30.)

Preliminary Work. — Model drawing, or drawing from type solids as they appear from one point of view, is the basis of all pictorial representation. Continued practice, intelligently guided by principles, will insure correct, accurate drawings.

Convergence. — In reviewing convergence at unequal angles, have the pupils sketch objects which will illustrate the condition, — boxes, books, etc., as in Fig. 51.

Fig. 51.

Proportional Measurement. — Give special attention to testing sketches by means of proportional measurement.

Sit erect; hold the pencil vertically at arm's length in the position indicated in Fig. 52, *A*. Close one eye; with the other sight over the top of the pencil to what appears to be the highest point on the object; and over the thumbnail, held against the pencil (see *B*), sight the lowest point visible on the object. A certain distance on the pencil will now appear to cover the
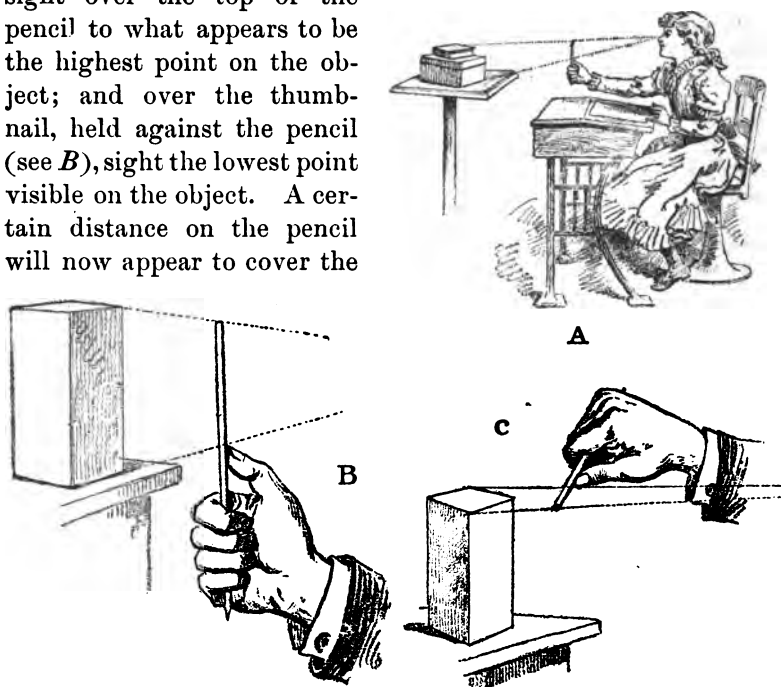
Fig. 52.

entire apparent height of the object. Now, turning the pencil horizontally, the entire width may be measured in a similar way (see *C*). By comparing the two measurements on the pencil, their relative lengths may be determined.

Such measurements should always be taken at arm's length. *They do not give size;* they give *proportion only.* They should be used principally *to test* sketches. As a rule, the first lines of the sketch should be drawn as they appear to the unaided eye, that the judgment of proportion may be trained.

a. In teaching the use of diagonals to find centers, have the pupils
    study the square prism, with diagonals, etc., drawn upon
    its faces with chalk.
b. Sketch cubes and square prisms, and locate centers of fore-
    shortened faces by means of diagonals.

Use of Diagonals to find Centers. — The quickest method by
which to determine the exact center of a rectangle is to draw
its diagonals.   Diagonals, in pictorial
drawings of rectangles, show the picto-
rial centers, and are of great use to the
student.   Fig. 53, *a*, shows the center
of a square face, *b* of an oblong face,
and *c* a point one fourth the length of
the oblong face from its further edge.
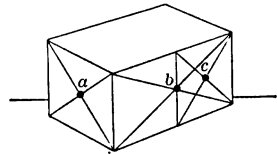
Fig. 53.

The location of ornament may often be determined by using
diagonals and diameters.   For example, lead the pupils in
studying Fig. 53, to see that in the case of *a*, *b*, and *c* the
diagonals find the centers and determine important points in
the ornament.   Notice, in the picture of the cube, that the
diagonals of the foreshortened faces locate their centers, through
which the diameters may be drawn.   All parts of the fore-
shortened ornament may be located by means of these diameters
and diagonals.

**Page 20. Use of Diagonals in Representing Foreshortened Orna-
    ment. —**

a. Draw margin lines.
b. Within $\frac{1}{2}''$ of the upper left corner of the margin locate the
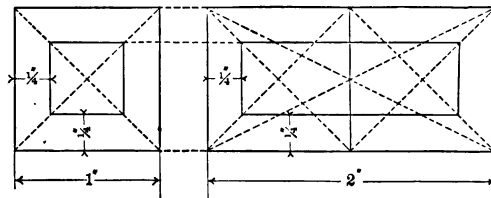
Fig. 54.

first lines, and draw the figures shown in Fig. 54. These represent the side and end of a square prism $1'' \times 2''$, upon which a border $\frac{1}{4}''$ wide has been drawn.
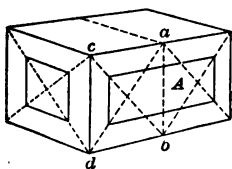
Fig. 55.

1. Make an accurate picture of a square prism having the proportions of that just drawn, but as large as will look well in the space. Represent it turned at oblique angles as indicated in Fig. 55.

2. When the drawing is correct, draw the border upon the face, as shown in Fig. 55, locating it by means of diagonals. When the oblong face (*A*, Fig. 55) has another proportion, the border may be located by means of the diagonals of an approximate square, *abcd*.

Page 31. Use of Diagonals in the Representation of Models. —

a. Draw margin lines.

1. At the left draw the picture of a cube divided into half-cubes, as shown in Ill. 57, or cut in the form of steps, as in Ill. 58.

2. At the right draw the picture of a square pyramid, locating its axis as shown in Ills. 62 and 63. Sketch the base first.

Page 32. Triangular Prism. —

a. Draw margin lines.

1. Draw the picture of a triangular prism, locating its upper corners as shown in Ill. 59. The apex of the prism may be located as indicated, by sketching the end of a square prism having the same base, and finding its center by diagonals. The apex of the triangular prism will be found somewhere in a vertical line passing through this center. The better way is to sketch the prism as it appears, and use the square and diagonals only as a test.

Page 33. Use of Diagonals in the Representation of Objects. —

1. Draw a simple object based on the triangular prism or pyramid. (See Ills. 60, 61, 65, and 66.)

In Ill. 60, diagonals locate the ornament in the center of the cover of the book; in Ill. 61, they assist in locating the clasp of the handbag. In Ills. 65 and 66, the accuracy of the drawing may be tested by drawing the diagonals of the base. The apex, if correctly drawn, will be found directly above the center of the base. Ill. 64 shows the construction lines of the drawing of the metronome.

Allow the pupil great freedom in selecting the objects he is to draw as applications of principles taught. Encourage him to do his very best.

Show that the same principles apply to large objects like houses or barns.

Page 34. Group. — Pictorial composition, or grouping, is the art of arranging objects in a picture to suggest a story pleas-
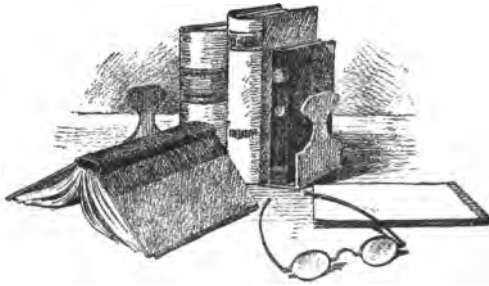
Fig. 56.

antly. A mere collection of objects is not necessarily a group; they must be arranged with reference to some one principal object, occupying the most prominent position, to which all the others are accessory, simply leading up to the principal. For example, in the group, Fig. 56, the book opened face down is the *principal object*, and the other objects are *accessory*.

The objects should be placed so that the eye may comprehend the whole group at once, without being attracted successively by different accessories. As a rule, avoid parallel lines in

grouping; that is, do not place all objects at the same apparent level, nor allow long lines in two adjacent objects to have the same direction. The most satisfactory groups are generally triangular in mass, as shown in the illustration on page 87.

Be sure to sketch *each* object entire, visible and invisible parts, to insure room for each object to stand in its proper position on the ground. Unless this is done, two adjacent objects are often drawn, occupying the same, or parts of the same, space. In Fig. 57, the glass may touch the water bottle, but should not enter its side, as it must do unless sufficient room is allowed between their bases.

In finishing such groups, give most attention to the principal object, bringing out clearly its important and characteristic marks. Emphasize only essential details.
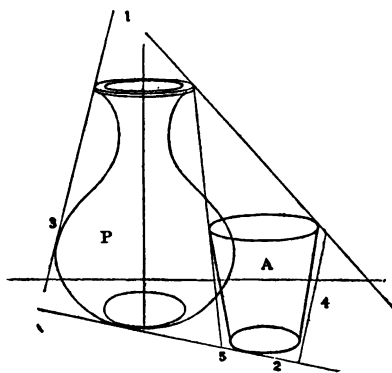
Fig. 57.

    a.   Practice arranging and sketching groups. Make them interesting. Let each suggest an incident or tell a story. In sketching, a good order of steps is as follows (see Fig. 57) : —

        1. Indicate on the paper extreme width and height of group, 1–2, 3–4.
        2. Sketch the entire mass of the group, 1–3–5–2–4.

3. Determine and indicate the relative positions and sizes of individual objects.
4. Sketch each object in mass ; indicate ground line.
5. Correct, if necessary.
6. Draw carefully the principal object.
7. Draw the accessories.

b. Draw margin lines.

1. Make a sketch from nature, and draw a simple group containing objects which involve the use of diagonals in one or more of the ways indicated in the foregoing pages. (See Ills. 67, 68, 69, and 70.)

SKETCHING FROM NATURE.

The pupils of the eighth grade in school are far enough advanced to do considerable outdoor sketching. Each one of them should be supplied with a little sketch book of manilla paper, and encouraged to use it constantly. Pupils of classes in city schools should be interested to take their sketch books with them on their excursions into the country.

At first, the pupil may find it best to sketch such natural forms as may be suggested by his school work; but later, any object or group which attracts attention as pleasing, — such, for example, as those shown on the next page in Fig. 58, — may be attempted. Select simple subjects; do not be too ambitious at first.

The same steps are to be taken in outdoor sketching that were taken in the schoolroom when sketching from objects. Practice will secure good results.

Encourage sketching in connection with work in History, Geography, and Natural Science.

Show the pupils examples of good pictorial art, photographs of historic buildings and their ornament, examples of carved and molded enrichment, vases, and other beautiful forms. If a museum of art is in the vicinity, encourage the pupils to visit it often, and lead them to love and look for the beautiful in all things.

RESULTS.

The pupil should soon form the habit of thinking *solids* when studying the *drawing* of solids; that is, he should think in three dimensions, — height, width, and thickness.

Fig. 58.

In object drawing, the fewest lines possible should be used to graphically represent the object. No line should be meaningless.

Many simple, thoughtful drawings are better than one or two laboriously finished to the finest detail. A simple drawing may show the *character* of the object, and that is of more importance than any particular detail. In objects and groups a suggestion of light and shade may be added.

While it may not be possible to get much "feeling" into the drawings, the pupils should at least know something of the "handling" required to produce the effect of difference in texture. These different handlings can hardly be described, but they may be illustrated. Generally speaking, a delicate

a   b   c   d   e
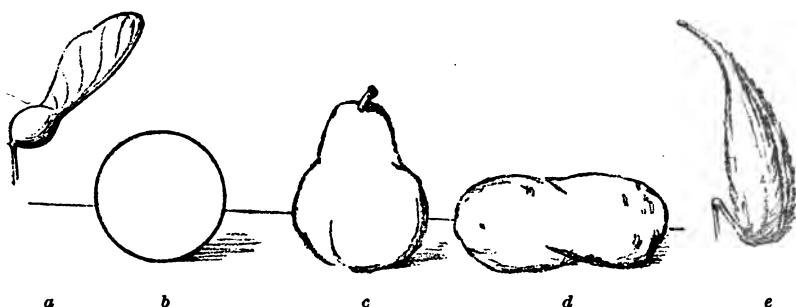
Fig. 59.

line, *a* in Fig. 59, indicates thinness and delicacy of structure ; an even, rather narrow, gray line, *b*, indicates contours of objects having smooth, even surfaces ; broken gray lines of different strengths, *c* and *d*, indicate irregular and rough surfaces ; a broad gray line, *e*, almost invariably gives the effect of very rough, woolly, or fuzzy surfaces.

But, after all, no fixed rules can be established for the use of lines to give texture. If the artist *thinks* texture while drawing, his lines will show it. If he admires a peculiar kind of line and always uses that, his drawings will be conventional and uninteresting.

Model and object drawing should develop an appreciation of good pictorial art and lead the pupil to look for and love the beautiful in all things.

ILLUSTRATIONS.
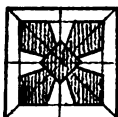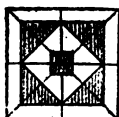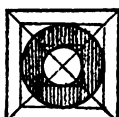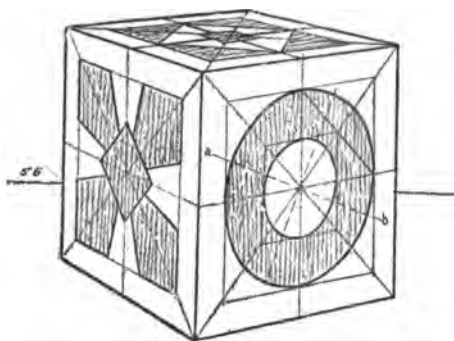
56. A cube with ornaments (*A*, *B*, and *C*) foreshortened.
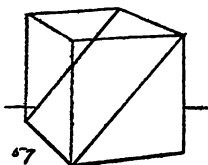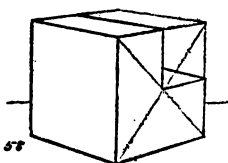
57. A cube cut to show a half-cube.

58. A cube cut into the form of steps.
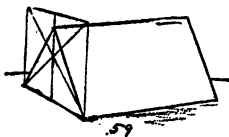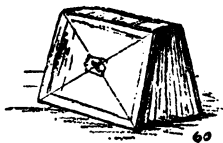
59. A triangular prism, with lines showing manner of testing its accuracy.

60. A book.

61. A handbag.

62, 63, and 64. Pyra-
mids with axes. Ill.
64 shows the construc-
tion lines of the metro-
nome.
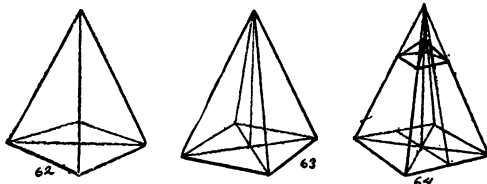
65. An ornamental ther-
mometer.
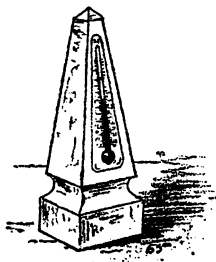
66. A metronome.

67. First stages of draw-
ing Ill. 68.

68. A group.

69
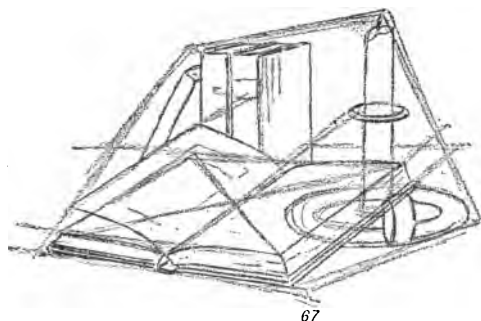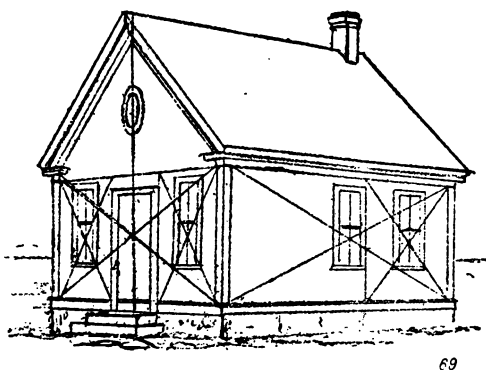
69. First stages of draw-
ing Ill. 70.

70. A drawing of the ap-
pearance of the school-
house whose plan and
elevations are given on
page 9 of Book VIII.

ILLUSTRATED DEFINITIONS.

ILLUSTRATED DEFINITIONS.

GEOMETRIC SOLIDS.

A Solid is space inclosed by surfaces — it has length, breadth, and thickness. In art, the term may be applied either to a model or an object.

Sphere. A solid bounded by one curved surface, every part of which is equidistant from its center. A solid formed by the revolution of a circle upon its diameter.

Hemisphere. Half a sphere. A solid obtained by bisecting a sphere with a plane passing through the center.

Spheroid. A curvilinear solid bounded by one curved surface, all plane sections of which are ellipses or circles.

Prolate Spheroid, Long Spheroid, or **Ellipsoid.** A curvilinear solid, formed by the revolution of an ellipse upon its major axis.

Oblate Spheroid or **Flat Spheroid.** A curvilinear solid formed by the revolution of an ellipse upon its minor axis.

Ovoid. A solid having the form of an egg. A solid formed by the revolution of an oval upon its axis.

Cylinder. A roller-like body, with flat, circular ends. A solid formed by the revolution of a rectangle upon one of its diameters.

Half-cylinder. A solid formed by dividing a cylinder with a plane passing through its axis.

Circular Plinth. A very short cylinder. A cylinder in which the height is less than the diameter of its flat, circular faces.
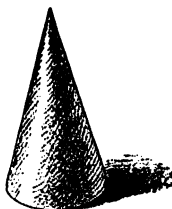
Cone. A solid having a circle for its base, and tapering to a point, or vertex. A solid formed by the revolution of an isosceles triangle upon its altitude.

Circular Frustum. That part of a cone which remains when the top part is cut off by a plane parallel with its base.
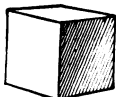
Cube. A solid bounded by six equal square faces.
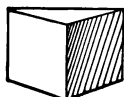
Half-cube. A solid formed by dividing a cube upon a diagonal of one face. A half-cube is a triangular prism.

Prism. A solid whose ends are similar, equal, and parallel, and whose sides are parallelograms.

Square Prism. A prism whose ends are square.

Square Plinth. A very short square prism. A plinth in which the height is less than the diameter of the square faces.

Triangular Prism. A prism whose ends are triangles.

Pentagonal Prism. A prism whose ends are pentagons.
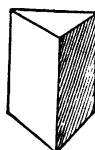
Hexagonal Prism. A prism whose ends are hexagons.

Octagonal Prism. A prism whose ends are octagons.

Pyramid. A solid having one base bounded by any number of straight lines, and having the same number of triangular faces with a common vertex.

Square Pyramid. A pyramid whose base is a square.

Square Frustum. That part of a square pyramid which remains, when the top part is cut off by a plane parallel with its base.
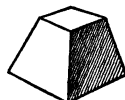
Triangular Pyramid. A pyramid whose base is a triangle.

Pentagonal Pyramid. A pyramid whose base is a pentagon.

Hexagonal Pyramid. A pyramid whose base is a hexagon.

Octagonal Pyramid. A pyramid whose base is an octagon.

Truncated Solid. That part of a cylinder, cone, prism, or pyramid, which remains, when the upper part is cut off by a plane at an oblique angle with the base.

DETAILS OF SOLIDS.

Surface is the boundary of a solid; it has length and breadth, but no thickness. In art, the outside of a thing is considered its surface.

Face. A part of a solid (*a*) bounded by edges.

Edge. A part of a solid, where the surface abruptly changes its direction (*bb*). A part of a solid where two faces meet.

Outline. The line, real or apparent, by which a figure is defined.

Corner. A part of a solid (*c*), where three or more edges meet.

Point. A point has position only, without size; but in drawing it is indicated by a dot, and represents a corner, or marks position.

Line. The boundary of a face. A line has length only; but in drawing it is indicated by a fine mark of the pencil or crayon, and represents an edge or an outline.

Straight Line. A line which has the same direction throughout its length.

Curved Line. A line which constantly changes its direction throughout its length.

Broken Line. A line made up of very short straight lines or of dots.

NOTE. — When the word "line" is used alone, a straight line is meant.
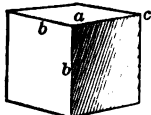
Positions of Lines.

According to their positions, lines are *horizontal, vertical,* or *oblique.*

Horizontal Line. A line which is level.

In drawing, a line which extends directly toward the right and left of the page is said to be horizontal. Thus, *a* is a horizontal line.

a

Vertical Line. A line which is perpendicular to a horizontal.

In drawing, a line extending directly toward the top and bottom of the page is said to be vertical. Thus, *b* is a vertical line.

NOTE. — Vertical and perpendicular have not the same meaning. A *vertical* line always points up and down; but any line forming a right angle with another is *perpendicular* to that line, no matter what its direction may be. Thus, *a* is *perpendicular* to *b*, although not a *vertical* line.
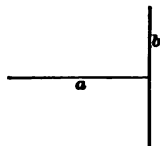
Oblique Line. A line which is slanting to the right or left. Thus, *c* and *d* are oblique lines. If the upper end of the line leans toward the right, it is called a *right-oblique* line, as *d*; if toward the left, a *left-oblique* line, as *c*.
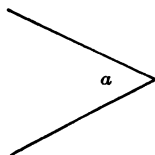
.
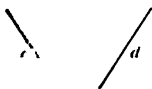
Relation of Lines.

In their relation to each other, lines may be *parallel* or *at an angle*.

Parallel Lines. Two or more lines that are the same distance apart throughout their length.
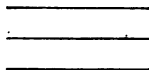
✗**Lines at an Angle.** Lines that are not parallel.

Angle. The difference in direction of two lines, which meet at a point, is called an angle. Thus, *a* is an angle.

Angles are divided according to the directions of their lines into *Right Angles* and *Oblique Angles.* ·

Right Angle. An angle formed by one line meeting another in such a way as to make the two adjacent angles equal. Thus, *a* and *b* are right angles. The lines forming these angles are *perpendicular*. (See note under "Vertical Line.")
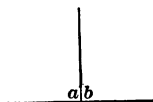
Oblique Angles. All angles which are not right angles are oblique. Oblique angles are either *obtuse* or *acute*.

Obtuse Angle. An angle that is greater than a right angle. Thus, *a* is an obtuse angle.
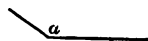
Acute Angle. An angle that is less than a right angle. Thus, *b* is an acute angle.

NOTE. — The lines forming an angle are called its *sides ;* the point at which they meet is called the *vertex* of the angle.

GEOMETRIC FIGURES.

Plane. A surface on any part of which a straight line may be drawn in any direction.

NOTE. — The top of the desk, if it can be imagined without thickness, may illustrate a plane.

Geometric or **Plane Figure.** A portion of a plane limited by lines.

Rectilinear Figure. A portion of a plane limited by straight lines.

Curvilinear Figure. A portion of a plane limited by curved lines.

Mixtilinear Figure. A portion of a plane limited by both straight and curved lines.

Triangles.

**A Triangle** is a plane figure having three sides and three angles.

Triangles are divided into six classes : according to their angles, into *Right-angled, Obtuse-angled,* and *Acute-angled* Triangles ; according to the relative lengths of their sides, into *Isosceles, Equilateral,* and *Scalene* Triangles.
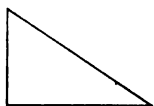
Right-angled Triangle. A triangle having one right angle.
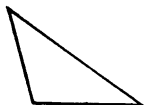
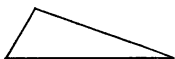**Obtuse-angled Triangle.** A triangle having one obtuse angle.
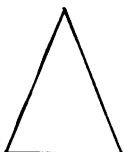
Acute-angled Triangle. A triangle having all its angles acute.

Isosceles Triangle. A triangle having two of its sides equal.

Equilateral Triangle. A triangle having all its sides equal.

Scalene Triangle. A triangle having no two of its sides equal.

NOTE. — Every triangle may have two names — one given it on account of its sides, the other on account of its angles. For example, an equilateral triangle is also an acute-angled triangle, for having three equal sides always gives it three acute angles.

Quadrilaterals.

Quadrilateral. A plane figure having four sides.
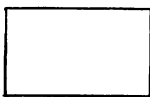
Rectangle. A quadrilateral whose angles are all right angles.

Rectangles are divided into *squares* and *oblongs.*

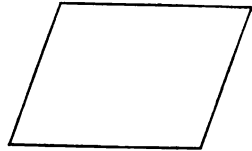**Square.** A rectangle whose sides are equal.
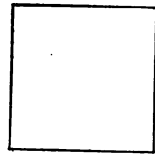
Oblong. A rectangle whose adjacent sides are unequal.

Rhombus. A quadrilateral whose sides are equal, two of its opposite angles being acute, and the other two obtuse. A *Diamond* is a rhombus.
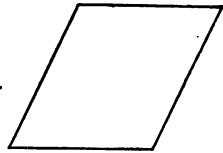
Rhomboid. A quadrilateral whose angles are like those of a Rhombus, but only its opposite sides are equal.

**Trapezium.** A quadrilateral no two of whose sides are parallel.

Polygons.

A **Polygon** is a rectilinear figure having more than four sides. When all the sides and angles of a polygon are equal, it is called a *regular polygon;* when the sides or angles are unequal, it is called an *irregular polygon.* Geometrically, triangles and quadrilaterals are frequently classed as polygons.

Regular Pentagon. A polygon having five equal sides and five equal angles.
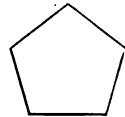
Regular Hexagon. A polygon having six equal sides and six equal angles.
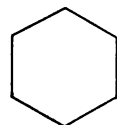
Regular Octagon. A polygon having eight equal sides and eight equal angles.
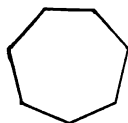
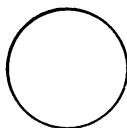A polygon having seven sides is called a **Heptagon.**
A polygon having nine sides is called a **Nonagon.**
A polygon having ten sides is called a **Decagon.**
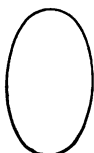A polygon having eleven sides is called an **Undecagon.**
A polygon having twelve sides is called a **Dodecagon.**

CURVILINEAR PLANE FIGURES.

Circle. A plane figure bounded by a curved line, every part of which is equally distant from a point within called the center.

A *semicircle* is half a circle, and is obtained by cutting a circle on its diameter. It is a *mixtilinear* figure.

Ellipse. A plane figure, bounded by a regular curve, every point in the outline of which is at the same combined distance from the foci.

Oval. A plane figure similar in shape to the longitudinal section of a hen's egg.
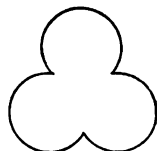
**Crescent.** A plane figure bounded by two curved lines, so arranged as to resemble the shape of the new moon.

Lens. A symmetrical plane figure bounded by two curved lines, curving in opposite directions.
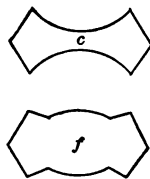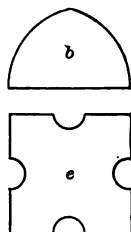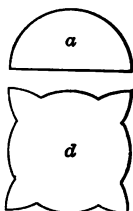
Trefoil. An ornamental figure of three foils or leaves, resembling a clover leaf.

Quatrefoil. An ornamental figure of four foils or leaves, resembling the petals of a flower.
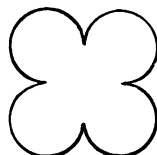
MIXTILINEAR PLANE FIGURES.

Of these there are, of course, an infinite number. They are used in art largely as inclosing forms for designs. The foregoing figures (*a*, *b*, *c*, *d*, *e*, *f*) illustrate these.
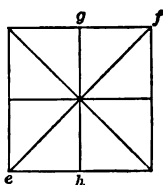
DETAILS OF GEOMETRIC FIGURES.

Base. That part of a rectilinear figure upon which it is supposed to rest, as *ab*.

Apex. The highest angle above the base, as *c*.

**Altitude.** The perpendicular distance from apex to base, as *cd*.
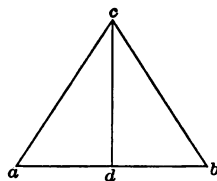
Axis.   Any line which divides a symmetrical figure into two equal and similar parts, as *ef* or *gh*.

Diagonal.   A line connecting opposite angles, as *ef*.

Diameter.   A line connecting the centers of opposite sides of a plane figure, as *gh*.

Diameters are sometimes distinguished as *vertical* and *horizontal*.

Diameter of a Circle.   A line drawn through its center, between opposite points in the circumference, as *ab*.
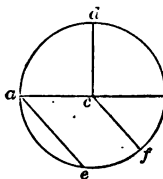
Radius of a Circle.   The distance from the center of a circle to any point in the circumference, as *cd*.

**Circumference.**   The unbroken line which bounds a curvilinear figure.

Arc.   Any part of a curve, as *db* or *ef*.

Chord.   A straight line connecting the extremities of an arc, as *ae*.

Segment.   The space inclosed by an arc and its chord.

Sector.   The space between any part of the circumference and two radii of a circle, as *bcf*.

Quadrant.   The space inclosed by one quarter of the circumference and two radii of a circle, as *dcb*.
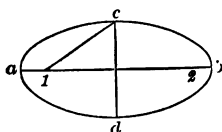

Long Diameter.   The longest straight line which can be drawn in an ellipse, as *ab*.

Short Diameter.   The shortest straight line which can be drawn in an ellipse, cutting the figure into two equal parts, as *cd*.

The long and short diameters of an ellipse are always perpendicular, and bisect mutually.

The terms *long* and *short diameter* are sometimes applied to the axis and the line representing the greatest width in an oval; as, long diameter *ab*, short diameter *cd*.
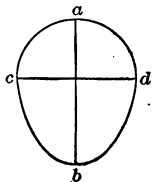
Foci.   Points in an ellipse from which the curve may be drawn mechanically, as *1, 2*. The distance from *c* to *1* always equals one half of *ab*.

MISCELLANEOUS TERMS.

Alternation. The repetition of one set of units separated by another set of units of a different character, in reciprocal succession.

Axis of Symmetry. A line drawn through the middle of a figure, so that the parts on one side are exactly repeated in a reverse order on the other. The axis may be drawn in any direction, being governed by the character of the figure; in the ornamental figure next below, it is vertical.

Bisect. To divide into two equal parts. ————+————

Bisymmetrical Design. A symmetrical arrangement in which one half is the exact reverse of the other.

Blocking-in Lines. Sketched lines which indicate masses.

Border. An ornament which consists of a regular repetition of ornamental units, along a line of indefinite length. The cut shows a familiar Greek border, composed of scrolls or spirals.
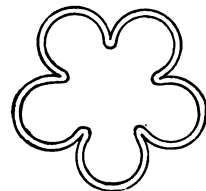
Botanical Drawing. The representation of plant form.
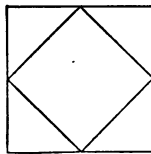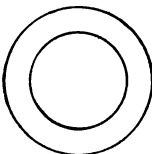
Center. A radial design.

Center Line. A line representing the center of a solid.

Cinquefoil. An ornamental figure having five foils or lobes, often applied in windows, panels, etc.

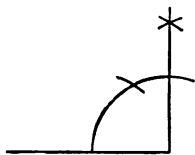**Circle.** In Christian art, a symbol of eternity.

Cinquefoil.

Concentric Circles and Squares.

Concentric. Having a common center.

Connecting Line. A line connecting similar parts in the drawings of two views of an object.

Construction. Making, or building; putting together the parts of any figure so as to give its peculiar form and structure. *Construction lines* are the framework upon which a drawing is made; they determine the distances, proportions, etc. *Construction,* as applied in geometrical problems, refers to the measurements and steps taken in the solution of the problems. The light lines in the cut show a method of construction in erecting a perpendicular at the end of a given line.

**Contrast.** The result of a juxtaposition of lines, forms, or colors of different characters.

Contrasted Harmony. (See " Harmony of Color.")

Conventionalization. The modifying of natural forms in such a way that the principles of their growth are retained and unimportant details omitted or simplified. A conventional form is a form idealized according to the evident intent of nature.

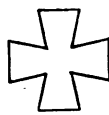**Cordate.** Resembling a heart in outline.
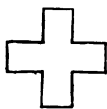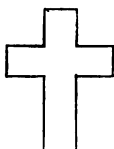
Greek Cross.	Latin Cross.	St. Andrew's Cross.	Maltese Cross.

Cross. Two bars placed transversely upon each other in various ways, each form having its own name. A symbol of suffering. Some of the more common crosses are shown in the illustrations.
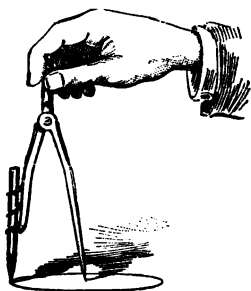
Dashed Line. A series of dashes arranged in line. Invisible parts of objects are represented by dashed lines.

Describe a Circle. To draw with a compass. The accompanying cut shows the position of the hand, while describing a circle with the compass.

Design. The plan, combination, or arrangement of any construction or ornament for a given purpose, whether constructive

or decorative. The word is often misused to apply merely to ornamental subjects.
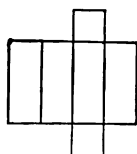
Detail. A selected part of a figure or object, usually drawn on a larger scale than is convenient for the whole.

Develop. To represent on a plane the entire surface of a figure.

Development. The entire *surface* of any solid or object when laid out upon one plane, as in the cut, which shows the development of a square prism. (See " Flat.")

Diaper. A panel or flat, recessed surface covered with wrought work in low relief. (This form of decoration was used greatly by the Moorish artists for the enrichment of the walls of the Alhambra.) An all-over pattern.

Distribution. An orderly disposition of the units in the field of a design.

Dot-and-dash Line. A series of dots and dashes alternated in line. Center lines are drawn with dot-and-dash lines.

Dotted Line. A series of dots, or very short dashes, arranged in line. Connecting lines are drawn as dotted lines.

Elementary Design. A pleasing arrangement of units within a given form, based on certain recognized principles.
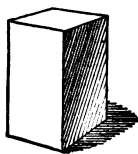
Elevation. A drawing giving the actual form and proportions of an object, as produced on one or more vertical planes. *Elevation* is opposed to *Plan*, which gives the actual form and proportion of an object as produced on a horizontal plane. Thus, in the three figures given the shaded cut shows the appearance of a prism, the *plan* shows the actual form and proportion of the base of the prism, and the *elevation* gives the form and proportion of one of the sides of the prism. Some objects require several different elevations, to show all the facts of form of all their details.

Field. That portion of any surface to be occupied by a design.

Flat. A development of the *whole* of an object; *e.g.*, the *flat* of a paper windmill is like a square with its diagonals.

Flat Ornament. An enrichment of a surface by means of contrast obtained by colors, or the use of light and dark.

Fret.   An ornament consisting of a series of lines or bands called *fillets,* which form a succession of angles, usually right angles, and are sometimes interlaced.
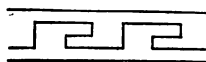
Full Line.   A continuous line.   Outlines and visible edges are always drawn with full lines.

Geometric Drawing.   The drawing of lines, surfaces, and solids with instruments.

Ground.   That upon which the object rests.   The field of a design.

Half-tint.   The darkening or shading of a surface, by means of a succession of parallel and equidistant lines, either vertical, horizontal, or oblique.
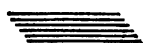
Harmony.   Such an adaptation of the parts of a design to each other, that they form a complete and pleasing whole.

Harmony of Color.   An arrangement of colors pleasing to a cultivated taste.   There are five principal Harmonies : —

1. **Contrasted.**   Composed of one color with neutrals.
2. **Dominant.**   Composed of tones of color in one scale.
3. **Analogous.**   Composed of colors from neighboring scales.
4. **Complementary.**   Composed of colors which, when mingled, will produce white or gray.
5. **Perfected.**   Usually composed of analogous or dominant combinations, with another color complementary to the prevailing tone.

Neutral colors may be added to all these combinations.

Hue.   Any color found in the spectrum, except the six standard colors.

Mass.   General shape, regardless of detail.

Neutral Color.   A term used in decorative arts, to denote a color which has little or no effect upon the hue of a juxtaposed color. A neutral color is sometimes called a *passive color.*

The neutral colors are *white, gray,* and *black.*

Ornament.   Any decoration or enrichment of form, color, or construction, intended to beautify an object.
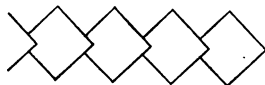
Overlap.   To lie over or upon.   When a part of an ornament seems to lie upon another part, it is said to *overlap.*

Overlap.

Perspective. The science underlying the representation on a plane of any object exactly as it *appears* to the eye from one fixed point of view. The shaded cut under "Elevation" is a drawing *in perspective* of the prism represented.

Pictorial Drawing. A representation of the appearance of an object or group, as seen from one point of view.

Plan. A top view. (See "Elevation.")

Plinth. A square member forming the lowest part of the base of a column; hence, any flat rectangular block, such as might be cut from a plank.

Proportional Measurement. A method of obtaining relative distances upon distant objects, by means of a pencil or similar implement.

Quadrisect. To divide into four equal parts.

Quality of a Color. The character of a color relatively considered. The quality of a color is said to be *warm*, when it approaches in appearance any of the colors in the red part of the spectrum; or *cold*, when it approaches in appearance any of the colors in the blue part of the spectrum. Colors acquire certain qualities by juxtaposition.

Quatrefoil. An ornament having four foils or lobes, often applied in panels, windows, etc. A symbol of the Evangelists.
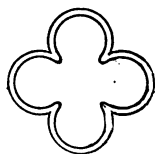
Quatrefoil.

Radiation. A method of arrangement in ornamental design, in which the parts diverge from a point. The *rosette* shown in the figure below is an example of radiation from a center. The horse-chestnut leaflets radiate from a point not in the center.

Repetition. An arrangement in which a number of similar forms or objects are placed in a row, or arranged round a center or over a surface.

Representation. Delineation by means of lines, light and shade, or color. All drawing is representation.
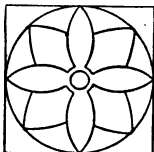
Rhythm. Repetition with accent. The frequent recurrence of some characteristic in the various parts of a design, without being obtrusive.

Rosette. A radiating ornament made of petal-like parts.

Scale of Color. The entire range of tones, from white, through its tints, a standard or hue, and its shades, to black.

Spectrum. A band of colors, produced by allowing rays of sunlight to pass through a triangular prism of glass, or other refracting medium. The spectrum contains red, orange, yellow, green, blue, and violet, usually called the *standard*, or *primary*, colors, and an indeterminate number of intermediate hues.

Standard Color. One of the six primary colors of the spectrum. A standard pigment color is one which imitates one of these, as closely as possible.

Symmetry. The result of a proper disposition and proportion of the parts of a design, forming a complete whole or unit.

Tangent. Touching at a single point. A line touching a curve which, even when produced, does not intersect it.

Tint. A color produced by adding light, or white, to a standard or hue.

Tone. One color in a scale of colors. Tone is also used to describe the general effect produced by any combination of colors.

Trefoil. An ornament of three foils or lobes, often applied in panels, windows, etc. A symbol of the Trinity.

Trisect. To divide into three equal parts.

Unit of Design. One of the distinct fractions, or parts, of a design, repeated uniformly to complete the figure. One of the spirals in the

Trefoil.

design under "Border" is the *unit of design*, which, repeated, makes the completed figure shown.

Unity. Such a combination of parts as to constitute a complete and pleasing whole. The result of uniformity in the character of the main lines or units in a design.

Value. In color, the power or force of a color upon the eye. It is directly proportional to the amount of light the color reflects.

Variety. The result of variation, or difference, in the details of a design, without affecting its unity.

View. A term used to indicate the standpoint of the observer, when making a drawing of an object, as the *end view*, when only the end is seen.

Working Drawings. Drawings which represent facts of form; drawings from which objects may be accurately made or constructed. In making a working drawing, the eye is supposed to be opposite each part of the object represented.

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